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Guidance for Conducting Facility Impact Assessment for Solid Waste Facility Site Assignment

in Support of 310 CMR 16.00

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This document is intended to guide parties, MassDEP staff and others in conducting or reviewing facility impact assessments for solid waste facilities in compliance with 310 CMR 16.00.

This document is intended solely as guidance. It does not create any substantive or procedural rights and is not enforceable by any party in any administrative proceeding within the Commonwealth. This document summarizes the requirements of 310 CMR 16.00 and provides guidance on approaches MassDEP considers acceptable for meeting the general requirements for conducting a facility impact assessment for solid waste facilities as set forth in these regulations. Parties using this guidance should be aware that there may be other acceptable alternatives for achieving compliance with general regulatory requirements.

Regulatory citations in this document should not be relied upon as a complete list of the regulatory requirements related to conducting a facility impact assessment pursuant to these regulations. Parties conducting a facility impact assessment for solid waste facility site assignment should consult 310 CMR 16.00.

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Executive Summary

Guidance for Conducting Facility Impact Assessment for Solid Waste Facilities in Support of 310 CMR 16.00

Preface

This Facility impact assessment Guidance Document (hereafter referred to as the Guidance Document) was developed to provide project proponents with information on how to complete facility impact assessments for the Department of Environmental Protection (MassDEP) when applying for site assignments under 310 CMR 16.00. This guidance document revises and supersedes MassDEP's previous guidance titled *Interim Risk-Evaluation Guidance for Solid Waste Facility Site Assignment and Permitting*, issued in June 2001. Important revisions include:

- assessments are now required for site assignments only, not for permits;
- assessments are no longer required for ash landfills;
- references to hydrogen sulfide issues, specifically for facilities handling construction and demolition debris materials;
- a section on recommended best management practices; and
- a provision that applicants address the full site-assigned project, rather than doing a phase by phase assessment.

This Guidance Document applies to those applicants who are applying for a site assignment or major modification to a site assignment on or after June 8, 2001 (the effective date of the newly revised Site Assignment Regulations at 310 CMR 16.00); and

The required assessment of the facility for purposes of site assignment may be conducted during the MEPA process for projects requiring an environmental impact report. If that assessment is complete and adequate, a second assessment will not be required in the site assignment process.

This Guidance Document does not apply to the following facilities or operations to which the solid waste regulations do not apply or that are exempt from the site assignment:

a. Facilities and operations to which 310 CMR 16.00 does not apply as specified at 310 CMR 16.05(2).
b. Conditionally exempt recycling operations as specified at 310 CMR 16.05(3).
c. Conditionally exempt composting operations as specified at 310 CMR 16.05(4).
d. Other conditionally exempted operations as specified at 310 CMR 16.05(5).
e. Facilities that are not required to obtain a site assignment or permit pursuant to the Determination of Need process specified at 310 CMR 16.05(6)-(10)
f. Facilities under construction as of June 8, 2001 (the effective date of the newly revised Site Assignment Regulations)

MassDEP uses this Guidance Document and the information provided by an applicant to determine whether a site is suitable for a solid waste facility assuming that the facility meets all other

requirements of 310 CMR 16.00. It is therefore incumbent upon the applicant to demonstrate and otherwise provide MassDEP with sufficient information so that MassDEP can determine whether or not to issue a favorable site suitability report. If the applicant fails to provide sufficient information as determined by MassDEP during its review of an application, then the application will be deemed to be technically deficient. The applicant will then be provided with an opportunity to supplement the information provided in the application.

When MassDEP reviews facility assessments and issues a report containing a finding that the site fails to meet the site suitability criteria, MassDEP may entertain written requests for reconsideration from the applicant stating the basis on which the reconsideration is requested. Such a request must be filed within 14 days of the issuance of MassDEP's site suitability report (310 CMR 16.14).

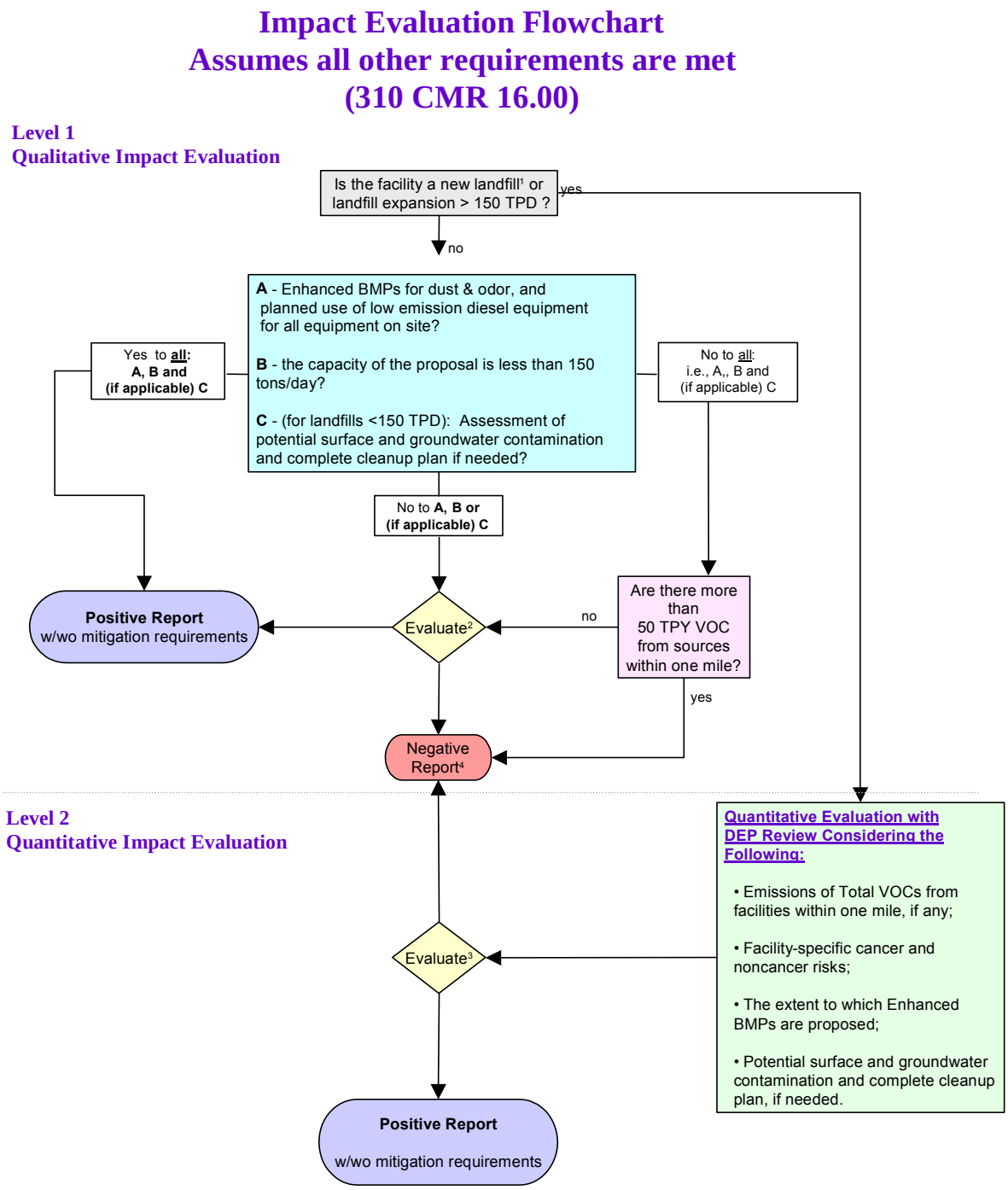
Unless MassDEP reaffirms or revises this guidance document within three years of the date it is issued, this guidance document will "sunset" and will no longer be applicable. Within two years of the date it is issued, MassDEP intends to initiate a review of the guidance and seek input from its Solid Waste Advisory Committee to determine whether the guidance should be maintained as is, revised, or eliminated.

Introduction

This Guidance Document presents MassDEP's current methodology for determining the level of assessment required for proposed solid waste facilities, provides guidance on the impact assessment procedures to be used for proposals, and provides a description of MassDEP's risk management approach.

Depending on features of the proposed facility such as its type and size, use of BMPs, and other factors, each proposed facility should be evaluated under a Level 1 (qualitative impact assessment) or Level 2 (quantitative impact assessment) approach. Figure 1 describes this approach, which is designed to help ensure that the level of assessment for a proposed facility is commensurate with the potential for risk from the facility. In general, small facilities that are well controlled receive a lower level of assessment (Level 1 assessment) than large facilities with the potential for greater impact (Level 2 assessment).

Figure 1. MassDEP Protocol for Selecting Level of Assessment



[1] "Landfill" includes MSW, Residuals, and C&D.
[2] Evaluation includes factors listed in the Executive Summary, page viii.
[3] Evaluation includes factors listed in the Executive Summary, page xi-xii.
[4] Request for reconsideration of a negative finding on site suitability allowed (310 CMR 16.14).

Proposed Level 1 and Level 2 assessments are reviewed by MassDEP following the steps depicted in Figure 1. For Level 1 assessments, the factors considered that bear upon whether a positive or negative site assignment report is issued by MassDEP include the following:

- facility type and size;
- extent to which BMPs are proposed;
- the type of land uses impacted by the facility;
- emissions of volatile organic compounds (VOCs) from other point sources within the area;
- -specific particulate matter sources, such as other solid waste management facilities, junk yards, auto salvage shops, bus and truck depots, etc. within the area; and
- (for landfills/expansions less than 150 tons per day) a commitment to develop and implement a cleanup plan for any surface water and groundwater contamination to comply with water quality standards in applicable laws and regulations (plan must be approved by MassDEP before the expansion is approved - See separate guidance titled *Guidance for the Assessment of Groundwater and Surface Water for Solid Waste Facility Site Assignment and Permitting*).

Transfer stations, construction and demolition (C&D) processing facilities, and small landfills are assessed using a Level 1 assessment.

The Level 2 assessment process is described below. It is based on the risk assessment procedures established by the National Academy of Science, builds upon existing risk assessment methods developed by the U.S Environmental Protection Agency (USEPA) (USEPA, 1989) and is similar to risk assessment methods used under the Massachusetts Contingency Plan (MCP).[1]

The Level 2 quantitative impact assessment is used to assess potential human health impacts due to inhalation of air contaminants from a proposed landfill that meets all of the facility and siting requirements contained in the siting regulations (310 CMR 16.00). Emissions of certain toxic pollutants (e.g., benzene, vinyl chloride, perchloroethylene, etc.) are included in the quantitative assessment of potential risks from proposed solid waste facilities (i.e., new landfills and landfill expansions over 150 tons a day). Total cancer and non-cancer risks associated with emissions of toxics from the proposed facility are estimated under this protocol. Criteria pollutants (i.e., ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, lead) will be evaluated elsewhere in the siting and permitting processes to ensure compliance with National Ambient Air Quality standards (which are federal standards that consider health impacts).

Potential groundwater impacts are not included in the quantitative risk assessment, because MassDEP believes that future groundwater impacts from the proposed facilities will be adequately controlled provided that facilities are constructed and operated in compliance with all applicable regulations. To protect important water resources, MassDEP has prohibited the siting of facilities in sensitive water resource areas. MassDEP has also modified the existing Site Assignment Regulations for Solid Waste Facilities to require increased setback distances from all water resources. This serves as a primary mechanism to prevent water impacts. In addition, MassDEP requires BMPs for stormwater, leachate collection, and water monitoring requirements

[1] Over time and with anticipated stakeholder input, MassDEP has plans to review additional elements so that facility impacts will be more fully addressed

for landfills. As part of the permitting process, proposed landfills and proposed expansions of landfills are also required to install double liners. In addition, for all proposed landfill expansions (for both Level 1 and Level 2 assessments), MassDEP requires an assessment of existing surface water and groundwater quality monitoring data for the existing facility. Depending on the level of contamination, the applicant may be required to prepare and implement a cleanup plan to achieve groundwater and surface water standards under the Solid Waste and Waste Site Cleanup programs.

To protect air quality and public health, and to minimize nuisance conditions, MassDEP encourages BMPs for dust and odors, and the use of low emission diesel equipment on-site[2]. In addition, the revised regulations require increased setbacks of facilities from sensitive receptors, including homes, schools, nursing homes, daycare centers, etc. which reduce potential inhalation risks to individuals in proximity of the facility. MassDEP is not recommending an assessment of mobile source emissions at this time, including those from on-site equipment, trucks carrying waste to the facility and emissions from all other off-site traffic, in the Level 2 quantitative impact assessment.

MassDEP is issuing separate guidance to address hydrogen sulfide emissions from landfills that handle C&D materials. While this risk assessment guidance document references types of BMPs that facilities should implement to reduce hydrogen sulfide emissions, this separate guidance recommends more specific management and control strategies. Based on this guidance, MassDEP may require additional assessment and/or controls at landfills where there is a potential for hydrogen sulfide emissions.

The following sections present brief summaries of the steps that comprise a Level 2 quantitative impact assessment.

STEP 1: Hazard Identification - Identification of Chemicals of Concern

Chemicals of concern (COC) from proposed landfills and their associated emission factors may be determined from the USEPA Landfill Gas Emissions Model (USEPA 1998). This model focuses on 47 COC (see Table 6 in the Guidance Document) with respect to emissions from landfill sites and vents, whether they are controlled or uncontrolled. The list of 47 chemicals is based on a USEPA publication, Compilation of AP-42 Emission Factors (USEPA 1997a) on chemicals that have been found to be emitted from landfills based on national testing of landfill emissions and from published documents. MassDEP has determined that all chemicals on this list for which published toxicity values exist should be included in the quantitative risk assessment. As toxicity data for the remaining chemicals become available, they will also be included in future quantitative risk assessments. On a case-by-case basis, MassDEP will review proposals from proponents wishing to evaluate and use other data (e.g., from similar landfills to the one proposed) to establish alternate lists of COC and/or emission factors. In particular,

[2] On-site diesel equipment refers to equipment used at the facility and does not include diesel vehicles transporting refuse into and out of the facility. At landfills, on-site diesel equipment could include equipment for excavating and moving dirt, for covering and compacting operations, and on-site power production. At waste handling facilities, on-site diesel equipment may include equipment that is used to move, consolidate and compact trash before it is taken off site.

MassDEP will consider capture rate data specified in existing MassDEP facility air permits. Approval from MassDEP on the approach to be used should be sought prior to initiating such an assessment.

If appropriate, project proponents should also address potential emissions and risks associated with special wastes, for which a permit will be requested, that contain potential COC that are not included on the list of 47 compounds and for which toxicity data exist. A special waste is only required to be addressed in the quantitative risk assessment if that waste comprises greater than fifty percent per year of the total waste taken in at that facility. In such cases, approval from MassDEP should also be sought prior to identifying any additional COC and emission factors for use in the quantitative risk assessment for those chemicals.

STEP 2: Dose Response Assessment

The project proponent should utilize the most current published toxicity values for the chemicals of concern. Current values are listed by MassDEP in this Guidance Document[3]. These toxicity values represent cancer slope factors and reference concentrations that have been published by USEPA (e.g., Integrated Risk Information System) or others, as appropriate. These values are updated from time to time by the organizations responsible for their development. The project proponent is responsible for ensuring that the most current values are used in the quantitative risk assessment.

STEP 3: Exposure Assessment

The project proponent should estimate potential exposures to chemicals of concern from the proposed facility based on appropriate modeling (USEPA Guidance for Landfill Gas Emissions Model) and other appropriate methods (e.g., dispersion models) that are specified by MassDEP in this Guidance Document.

The inhalation exposure pathway is quantitatively addressed. The Guidance Document specifies the modeling outputs, including for example, a peak annual average and long-term (30-year) average air concentration for each toxic chemical at the property line and beyond.

As mentioned above, if a facility proponent prefers not to utilize the USEPA emission factors in modeling facility emissions but wants to collect and/or use other information, such as monitoring data from a similar existing facility, MassDEP review and approval of the proposed alternative is required to ensure that it meets all appropriate requirements.

STEP 4: Risk Characterization

A quantitative risk assessment should be performed using the exposure estimates and the dose response information, determined as noted above. The multi-chemical, single pathway assessment should include an assessment of the total facility excess lifetime cancer risks and chronic and sub-chronic non-cancer risks. The quantitative risk assessment should also include a

[3] The project proponent should use toxicity data that are available at the time of the project assessment. Project proponents are responsible for using the most up-to-date values in their assessments.

discussion of the uncertainties, such as those associated with the hazard identification, dose-response, exposure assessment (including both modeling and exposure issues), and risk characterization steps.

STEP 5: Risk Management

Results of the facility impact assessment will be compared to MassDEP's risk management criteria, considering additional factors, as described below.

Risk Management Criteria for Level 2 Assessments

Absent other significant factors, the MCP risk management criteria (Excess Lifetime Cancer Risk = 1-in-100,000, Hazard Index = 1) will be applicable to the results of a quantitative assessment prepared for a Level 2 assessment. Additionally, proposed facilities that would pose *de minimis* risks (ELCR less than one-in-one million and a Hazard Index less than 0.1) will be generally approvable at any location. Where there are other significant emissions of VOCs in the immediate area, more stringent risk management criteria may be appropriate as discussed further below.

Additional Risk Management Considerations

The following additional factors will be considered by MassDEP when evaluating the appropriateness of a location for a proposed landfill and for permitting expansions of existing landfills:

- The aggregate emissions and associated potential risks, as described by the combination of the following two factors:
    1. the risk posed by the facility itself (quantitative estimations of the Total Facility Hazard Index and Excess Lifetime Cancer Risk); and
    2. the emissions of pollutants that can impact public health from nearby facilities (evaluated using an indicator, total VOC emissions from all point sources within 1 mile, unless otherwise determined by MassDEP, as listed in MassDEP's database[4], including existing waste facilities at the proposed location). The use of this indicator is predicated on the assumption that the higher the emissions of VOCs from adjacent air point sources registered in MassDEP's database, the higher the potential risk in the community affected by these facilities. The facility proponent may choose to conduct multiple facility source modeling and quantitative risk assessment of the adjacent sources[5] to provide a refined estimate of overall risk.

[4] Stationary Source Emissions Inventory System

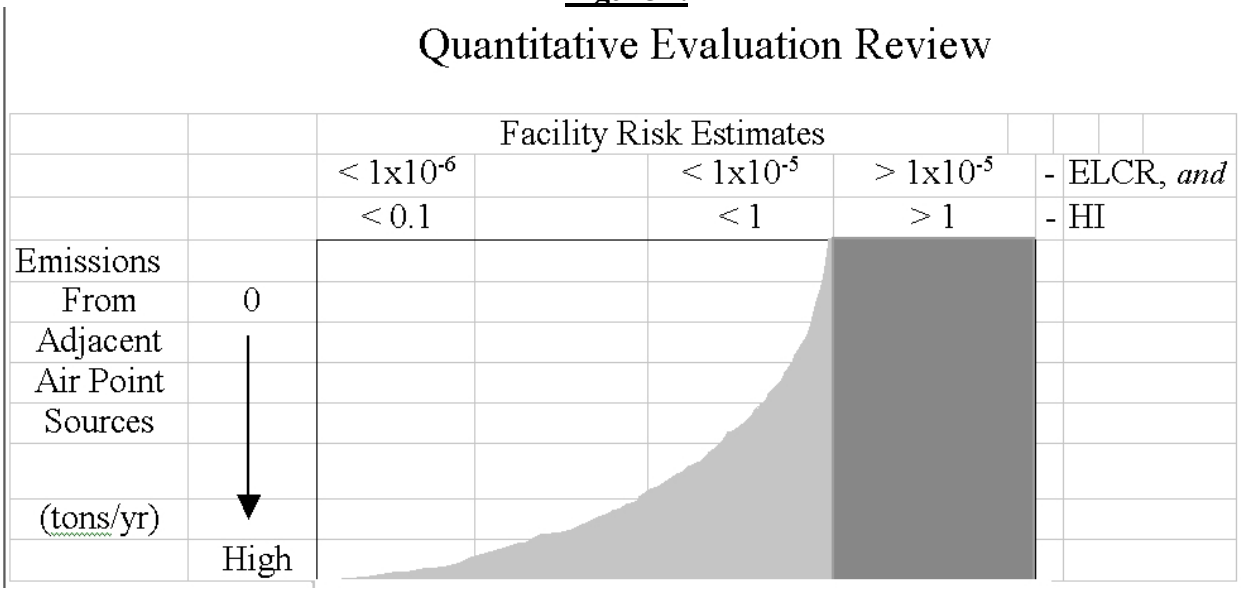
[5] The facility proponent should consult with MADEP prior to initiating such work. Such an analysis could be part of the initial proposal, prior to a requirement for mitigation, prior to the issuance of a negative site suitability report, or as part of a request for reconsideration.

- A commitment to develop and implement a cleanup plan for any surface water and groundwater contamination to comply with water quality standards in applicable laws and regulations (plan must be approved by MassDEP before the expansion is approved), if the proposed facility is an expansion of a landfill.
- Other factors affecting environmental conditions in the area, such as possible mitigation/offset measures offered by the proponent, expected future change to emissions from facilities in the area, the type of land uses impacted by the facility; specific particulate matter sources within the area, such as solid waste management facilities, junk yards, auto salvage shops, bus and truck depots, etc.; and the environmental impacts of not constructing the facility.
- Uncertainty of the available data.

Assuming that all other requirements are met, MassDEP would issue a positive site suitability report if the risk management criteria are clearly met, suggest mitigation measures if the results are near the proposed limits, or issue a negative determination, require changes to the proposal or require mitigation measures if one or more of the criteria are exceeded. Mitigation options may include enhanced controls on emission sources at the site and/or off-site mitigation.

Figure 2 graphically depicts MassDEP's approach to evaluating quantitative information that has been developed for the Guidance Document. The darkly shaded area to the right of the figure represents those facilities with an estimated total facility Excess Lifetime Cancer Risk greater than one-in-one hundred thousand or an estimated total facility Hazard Index greater than one. Outside that darkly shaded area, the facility itself poses an acceptable risk. In this latter case, the facility site can be approved unless emissions from adjacent air point sources are high. In that case, additional mitigation or additional assessment may be needed.

Figure 2.



Tools Available

MassDEP has developed a spreadsheet to assist in conducting a quantitative risk assessment for landfills. This spreadsheet addresses the default lists of chemicals suggested in this document. It may be accessed at the MassDEP home page at http://www.mass.gov/dep. For proposed facilities for which special wastes should be evaluated or which otherwise need to consider additional chemicals, the risks from these chemicals should be calculated separately and added to the risk determined using the spreadsheet.

This guidance document identifies the minimum components that the impact assessment report should include, explains how the impact report fits into the site assignment process and identifies specific submission requirements.

SECTION 1: Introduction

In June 2001, the Massachusetts Department of Environmental Protection (MassDEP) adopted revisions to the Site Assignment Regulations (310 CMR 16.00) which govern the siting of solid waste facilities in Massachusetts. In particular, 310 CMR 16.40 establishes the criteria and decision-making process MassDEP shall utilize in determining whether a site is suitable for a proposed solid waste management facility.

In October, 2001, the MassDEP Commissioner convened a Science Panel to review the Interim Guidance Document (June 8, 2001 Interim Guidance) and to provide recommendations for the assessment of cumulative impacts. The Science Panel report (http://www.mass.gov/dep/bwp/dswm/dswmpubs.htm#swac) recommended no clear next steps. As a result, no major changes to the impact assessment guidance are being made as part of this update. The main focus of this updated document is clarification of the previous Interim Guidance, including additional guidance on water resources assessment.

MassDEP is committed to ensuring that solid waste facilities are located and designed to minimize impacts to public health and the environment. Requirements for siting or expanding solid waste facilities or expansions call for enhanced measures to address potential facility-related impacts to the public. These measures include increases in required setback distances of the facility to sensitive receptors or resources, requirements to prevent water impacts, and qualitative or quantitative impact assessments, as determined by the size and characteristics of the proposed facility and its surrounding area. In addition, MassDEP is encouraging Best Management Practices (BMPs) for dust and odors, and the use of low emission diesel equipment for all on-site diesel equipment.

The revised solid waste site assignment regulations incorporate a systematic review process that evaluates the potential impacts of a proposed facility or expansion on public health. The level of assessment reflects the potential for risk from the proposed facility. The assessment should be based on the types and amount of wastes the facility proposes to handle. Small, well-controlled facilities receive a lower level of assessment than large facilities with the potential for greater impact. In addition to assessing site suitability based on facility-specific considerations, the revised regulations also take into consideration the impacts of existing sources of pollution or contamination in the surrounding area.

To protect air quality, public health and to minimize nuisance conditions, MassDEP encourages all proposed solid waste management facilities to incorporate Best Management Practices (BMPs) to control dust and odors in their proposals. In addition, MassDEP encourages facility operators to equip or retrofit all equipment on site with low emission diesel technology. MassDEP believes that use of such BMPs should greatly reduce fugitive particulate and other emissions and odors. MassDEP also requires increased setback distances of facilities from sensitive receptors including homes, schools, nursing homes, daycare centers, etc. to reduce potential risks to individuals living or working in the proximity of a solid waste facility. For larger landfills, a quantitative impact assessment should be conducted to assess facility-specific cancer and non-cancer risks associated with emissions of gaseous pollutants. In addition, for all

proposed facility types or expansions, total potential emissions[6] of volatile organic compounds (VOCs), determined using the MassDEP Stationary Source Emissions and Inventory System (SSEIS) database, should be evaluated as an indicator of industrial activity and/or the potential for emissions in the area that may cause or contribute to adverse impacts related to landfill gases.

To protect water resources, MassDEP requires increased setback distances from groundwater and surface waters. In addition, MassDEP requires that proposed landfills install double liners with leak detection and leachate collection devices and perform periodic water monitoring. As part of the facility impact assessment, proponents should evaluate potential groundwater and surface water impacts at landfills applying for expansions in either Level 1 or Level 2 assessments. MassDEP considers an approved plan for the remediation of any groundwater or surface water as a condition of the expansion permit approval. As part of the requirements for site assignment and permitting of landfills, MassDEP requires that a commitment be made to develop and implement a cleanup plan (approved by MassDEP) for any surface water and groundwater contamination to comply with water quality standards in applicable laws and regulations.

This Guidance Document for Solid Waste Facilities (hereafter referred to as the Guidance Document) is intended to be used by anyone seeking site assignment under 310 CMR 16.00. It summarizes the decision criteria to be used to determine whether and how a facility impact assessment should be conducted as part of a solid waste management facility siting application. The various components of the assessment process are defined and discussed as they pertain to solid waste management facilities.

Unless MassDEP reaffirms or revises this guidance document within three years of the date it is issued, this guidance document will "sunset" and will no longer be applicable. Within two years of the date it is issued, MassDEP intends to initiate a review of the guidance and seek input from its Solid Waste Advisory Committee to determine whether the guidance should be maintained as is, revised, or eliminated.

1.1 Applicability and Scope

Definition

A solid waste management facility is defined as "an established site or works, and other appurtenances thereto, which is, has been or will be used for the handling, storage, transfer, processing, treatment or disposal of solid waste including all land, structures and improvements which are directly related to solid waste activities". The Guidance Document addresses two general categories of facilities: landfills that process and dispose of refuse on-site and handling facilities that take in the waste and transfer it elsewhere. "Landfills" include municipal solid waste landfills, C&D landfills, and residuals landfills (such as ash.) Examples of handling facilities include transfer stations, C&D processing facilities and mixed-waste composting facilities. Those facilities that are exempt from the site assignment process under 310 CMR 16.05 are also exempt from Facility input assessment requirements. Many types of facilities may

[6] Potential emissions are defined as those that might be generated if a facility were to operate at a maximum rate continuously.

include both on-site disposal and waste-processing components. For facilities taking in multiple types of waste, the predominant waste generally dictates the level of assessment required by MassDEP. However, proponents of facilities that handle multiple wastes and proponents of multiple types of facilities at the same site should consult with MassDEP prior to proceeding with the assessment process. If the type of solid waste facility proposed does not fall into one of the categories identified by MassDEP, proponents should also consult with MassDEP prior to proceeding with the assessment process.

1.2 Accounting for Emissions from Other Facilities

While the Site Assignment Regulations in the past have addressed the cumulative impact of multiple solid waste disposal facilities greater than or equal to 300 tons per day in a municipality, they have not considered the impacts from other solid and non-solid waste sources in the area surrounding the proposed facility or expansion. The revised regulations address the issue of whether the generation of pollution or contamination from the proposed facility or expansion, taking into consideration the existing sources, will have a negative impact on public health. The assessment of cumulative impact is still a young science and there are many areas of uncertainty inherent in the process. MassDEP is committed to moving towards more comprehensive methodologies as they are developed.

MassDEP's current approach for evaluating the impacts of proposed solid waste facilities takes into consideration the emissions from existing sources using information on total emissions of air toxics (i.e., total volatile organic compounds (VOCs)) from the MassDEP Stationary Source Emissions and Inventory System (SSEIS) database. The SSEIS database contains emissions information for VOCs emitted from both major and minor point sources. The SSEIS database contains a list of registered facilities, along with emission information for "potential", "actual" and "permitted" facility emissions. Potential emissions represent maximum emissions that might be generated if a facility were to operate at a maximum rate continuously. Actual emissions reflect emissions that have occurred based on the facility's actual operating schedule. Permitted emissions include any MassDEP-imposed emissions restrictions for that facility. For calculating total emissions, total potential emissions of VOCs in tons per year (TPY) from all sources registered in the MassDEP SSEIS database within one mile of the perimeter of the proposed facility or expansion, unless determined otherwise by MassDEP, should be compiled by the project proponent. Information on total potential emissions is evaluated together with other quantitative and/or qualitative information about the facility, using MassDEP's risk management considerations and criteria as discussed elsewhere in this guidance, to make a decision about site suitability.

MassDEP chose to use total VOC emissions data as described above for this protocol for the following reasons: VOCs are an indicator of industrial activity as well as an indicator of emissions in the area that could potentially be associated with adverse impacts related to specific landfill gases. SSEIS information represents the best database for this information, given that Massachusetts tracks emissions of VOCs as precursors to ozone due to Massachusetts' non-attainment status for ozone. The VOC emissions information in this database is believed to be the most representative indicator of total point source emissions currently available. The assumption inherent in the use of this indicator is that the higher the emissions are from adjacent air point sources, the higher is the potential risk in the community affected by these facilities.

On a case-by-case basis, prior to requiring additional mitigation or issuing a negative site suitability report, MassDEP may allow multi-facility source modeling and quantitative risk assessment of adjacent sources to be used to more fully evaluate overall impacts[7].

SECTION 2: Facility Assessment Screening Protocol

The level of assessment that MassDEP requires for a proposed siting application is determined by a number of parameters related to the proposed facility and its surroundings. Figure 1 outlines the systematic protocol for determining the level of assessment an applicant should use to determine whether a siting request may be approved. The protocol involves two levels of assessment, including a Level 1 - Qualitative Impact Assessment and a Level 2 – Quantitative Impact Assessment.

MassDEP believes that emissions from large landfills may produce ambient air levels of these pollutants of potential concern to the general public. For this reason, applications to site larger landfills or expansions should include an assessment of potential air impacts in a quantitative risk assessment. MassDEP believes that gaseous emissions from very small and well-controlled landfills, which meet all applicable facility and siting criteria in the solid waste regulations (Table 1), are likely to be low. Thus, a qualitative assessment of emissions from very small landfills is deemed by MassDEP to be a sufficient basis for assessing their potential impacts.

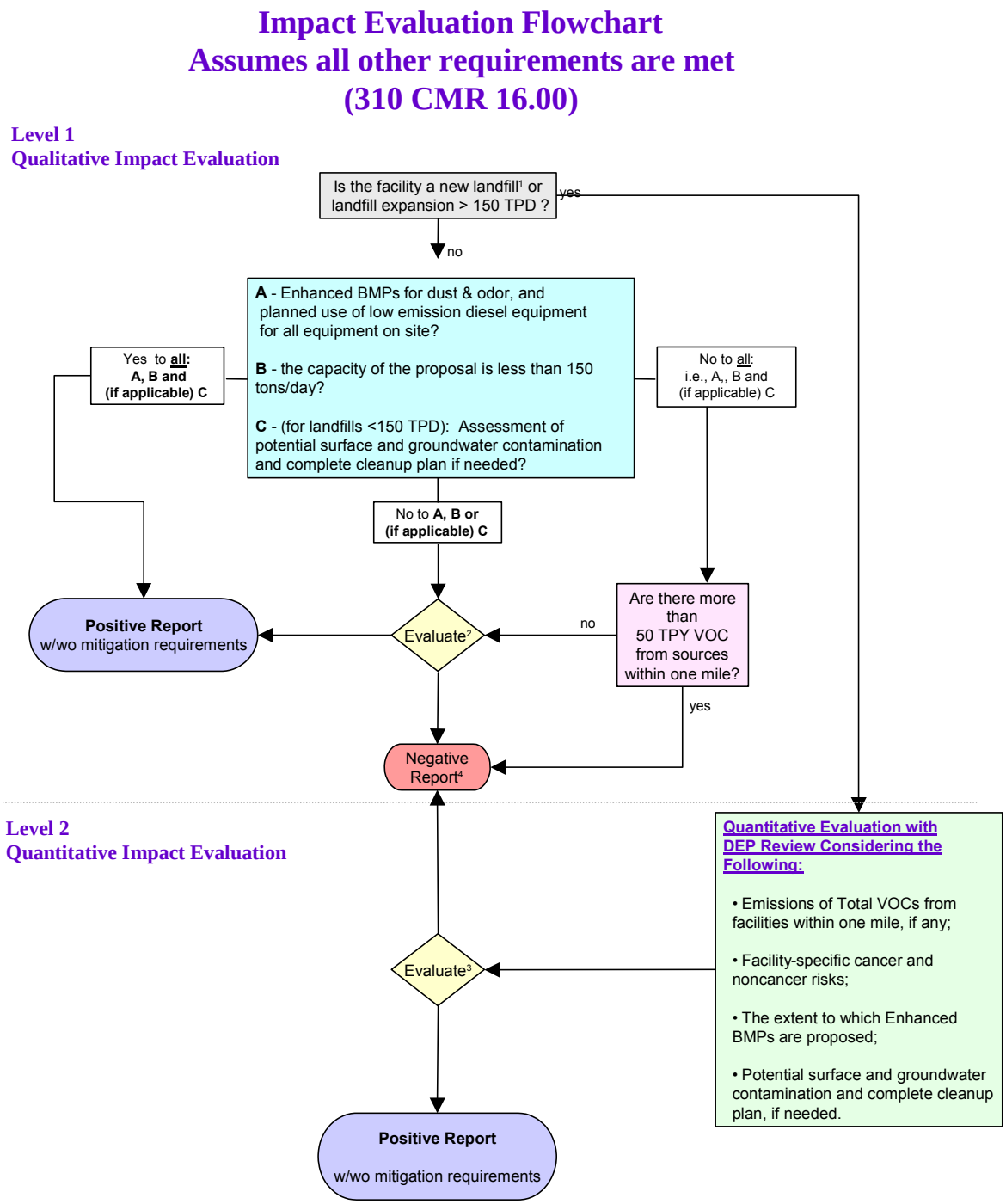
Proposed landfill expansions and new landfills that meet the criteria summarized in Figure 1 should undergo quantitative impact assessments. Landfill expansions differ from new landfills in that they may offer the opportunity to obtain site-specific information on ambient air emissions via on-site monitoring of the existing landfill that is seeking to expand. Such information may serve as a supplement to the LandGem model (USEPA, 1998) suite of COC and their associated emission factors. Proponents of new landfills may also use data from a similar landfill subject to prior approval by MassDEP. For expansion requests, the quantitative risk assessment should address the full site assigned project. For new facility requests, the entire facility should be addressed. When monitoring data are available as a basis for determining exposure point concentrations, a conservative approach should be used to conduct the risk assessment. The list of AP-42 COC should always be included in the assessment although this list may be supplemented with additional chemicals as indicated by monitoring results. In addition, the higher of the monitored concentration or concentration derived from an AP-42 emission factor should be used to conduct the quantitative assessment. Concentrations of VOCs emitted from decaying waste fall along a lognormal gas production curve, and vary significantly over the decaying process, influenced by the age of the waste and the particular set of environmental conditions characterizing the landfill. Since it is very difficult to determine at what point along the gas production curve a set of monitoring results may have been derived, MassDEP's policy regarding this issue is to use the higher concentration as an estimate of a worst-case concentration. Waste-handling facilities differ from landfills in that the waste is transitory and therefore is present at the facility for only a short period of time. Gaseous

[7] The facility proponent should consult with MassDEP prior to initiating such work. Such an analysis could be part of the initial proposal, prior to a requirement for mitigation, prior to the issuance of a negative site suitability report, or as part of a request for reconsideration.

emissions are much lower than they are at landfills where refuse is buried on-site and decomposes over a period of years. As a result, particulate emissions associated with the transfer and transport of refuse as well as emissions from on-site diesel equipment is of the most concern at these facilities. For this reason, MassDEP encourages implementation of BMPs and the use of low emission equipment on-site at these facilities to address fugitive dust and diesel emissions. MassDEP believes that use of BMPs will greatly reduce emissions of concern at these facilities.

Table 1. Summary of Revised Siting Requirements/Criteria **310 CMR 16.40**
Applicable and relevant state and federal standards, criteria, guidelines or allowable limits in written health policies [310 CMR 16.40(1)2.]
Groundwater Protection restrictions (Zone II's IWPA's, etc…) [310 CMR 40.40(3)(a), (c), (d)]
Setbacks from residences, schools, preschools, agricultural land, etc… [310 CMR 16.40(3)(a)(c)(d)]
Assessment of traffic congestion, safety, vehicle emissions [310 CMR 16.40(4)(b)]
Wildlife Habitat, ACEC, Wetlands Protection Act [310 CMR 16.40(4)(c)(d)]
Air Quality Impacts: [310 CMR 16.40(4)(c)(e)]
Nuisance Conditions: [310 CMR 16.40(4)(c)(f)]

Figure 1. MassDEP Protocol for Selecting Level of Assessment



[1] "Landfill" includes MSW, Residuals, and C&D.
[2] Evaluation includes factors listed in the Executive Summary, page viii.
[3] Evaluation includes factors listed in the Executive Summary, page xi-xii.
[4] Request for reconsideration of a negative finding on site suitability allowed (310 CMR 16.14).

The database on emissions from waste facilities other than landfills is limited. Detailed information on the types and concentrations of compounds emitted from waste-handling facilities has not been collected and compiled as it has been for landfills. The level of uncertainty introduced by these data limitations and the modeling and assessment processes would likely render a quantitative impact assessment of these facilities impractical given the current level of knowledge. As additional emissions data are collected on these facilities and modeling and assessment methodologies improve, MassDEP may determine in the future that quantitative assessment should be conducted for these facilities as well.

In addition to qualitative and quantitative assessments for determining site suitability, a facility may be subject to periodic or ongoing monitoring requirements on a case-by-case basis. The details of these requirements, if any, will be specified in the facility permit. Other requirements of the solid waste regulations as well as of the USEPA federal Clean Air Act (e.g., the assessment of criteria pollutant impacts from the facility) are not addressed in the Guidance. However, an assessment of facility emissions relative to National Ambient Air Quality Standards (NAAQS) will be done elsewhere in the siting and permitting processes (see Table 1).

To summarize, a qualitative impact assessment is required for new waste-processing facilities or expansions and smaller landfills or expansions which take in less than 150 tons per day of refuse. Waste handling facilities include transfer stations and C&D processing facilities. Small landfills include municipal solid waste, C&D, and residuals landfills or expansions that take in less than 150 tons per day of refuse. Siting requests for these facilities will be evaluated based on the acceptability of proposed BMPs (see Tables 2 and 3), proposed refuse capacity, and VOC emissions from other major and minor point sources within one mile of the facility. Please note that MassDEP is issuing guidance for addressing hydrogen sulfide emissions from landfills, especially from landfills that accept C&D waste, fines, or residuals. While MassDEP does not currently require a quantitative risk assessment for small landfills, MassDEP may require additional assessment and/or controls at these landfills where there is a potential for hydrogen sulfide emissions. Quantitative Risk Assessments should be conducted for large landfills or expansions. In this context, a large "landfill" is defined as a municipal solid waste, C&D, or residuals landfill that takes in more than 150 tons per day of waste. Additional qualitative facility-specific or site-related information may be considered on a case-specific basis to make a final determination on site suitability.

2.1 Best Management Practices

MassDEP expects that facilities will implement Best Management Practices (BMPs) in the design and operation of a proposed new solid waste management facility or expansion to reduce or mitigate potential impacts for specific areas of concern. These areas of concern include: groundwater protection; surface water protection; air quality protection (noise, dust/particulates, hydrogen sulfide and other emissions, and odor); fire protection; and insect/rodent control. In the context of this guidance, a BMP is a preventive technology or measure that is implemented to limit potential impacts by facilities and to address public health and nuisance concerns. A facility applicant should provide a listing and discussion of proposed BMPs that address these areas of concern.

The extent to which an applicant proposes BMPs and the BMPs' purported effectiveness[8] in reducing or mitigating potential impacts will be important factors in the MassDEP decision-making process regarding the adequacy of a facility's impact assessment report. For example, particulate emissions from solid waste management facilities are difficult to estimate using existing information and methods. Yet they are one of the primary pollutants of concern for many facilities, especially those conducting a Level 1-qualitative impact assessment. The implementation of BMPs and the use of low-emission equipment on site can effectively control emissions of particulates from facilities, thus reducing the need for a quantitative assessment of impacts, especially for facilities initially conducting Level 1 assessments. Facility proponents should implement appropriate BMPs to minimize fugitive dust emissions, hydrogen sulfide emissions, odors and diesel emissions to meet the Air Quality Regulation.[9]

Facility proponents should identify BMPs that are applicable to the operations of the facility and that will minimize facility impacts to the maximum practicable extent. Tables 2 and 3 contain a list of MassDEP-approved BMPs. However, these BMPs are given only as suggestions for applicants' consideration. Other methods not listed will be considered by MassDEP provided that they adequately control the environmental issue of concern. Specific BMP requirements will be established in the applicant's facility permit. MassDEP may require reporting on the effective implementation of BMPs as a permit condition.

[8] To evaluate the effectiveness of BMPs, MassDEP may require a facility, as part of it s permit, conduct ambient air monitoring for particulates and other substances of concern during facility operation.

[9] See for example 310 CMR 7.01: General Regulation to Prevent Air Pollution:

(1) No person owning, leasing, or controlling the operation of any air contamination source shall willfully, negligently, or through failure to provide necessary equipment or to take necessary precautions, permit any emission from said air contamination source or sources of such quantities of air contaminants which will cause, by themselves or in conjunction with other air contaminants, a condition of air pollution.

Table 2. MassDEP Approved BMPs for Landfills

(MSW Landfills, Ash Landfills, and C&D Landfills)

	Areas of Concern for Potential Risk					
MADEP Approved BMPs	Groundwater	Surface Water	Air Quality	Fire Protection	Insect/Rodent	
Active Face Of Landfill:						
Using alternative daily cover materials that reduce dust, odors, and vermin to a greater degree than standard soil type materials (these would include manufactured products such as Posi-Shell, polymer modified foams, tarpaulins, etc.)			×	×	×	
Maintain as small an active face as possible			×	×	×	
When using C&D fines or residuals as cover or grading and shaping material, mix with soil			×			
When using C&D fines or residuals as cover or grading and shaping material, ensure that the processing facility has a program in place to separate gypsum materials prior to processing			×			
Diesel Emission Controls:						
Replacing old diesel equipment with new, lower emission diesel equipment			×			
Using electrically powered motors			×			
* Retrofitting ninety percent (90%) of all 1997 and older diesel engines used wholly or partially on site for more than 10 hours per week			×			
Replacing diesel powered equipment with compressed natural gas, liquid natural gas or liquid petroleum gas equipment			×			
For off-road engines, using only cleaner on-road diesel fuel			×			
For on-road engines, using only cleaner ultra low sulfur diesel fuel			×			
Minimizing idling of equipment by turning off engines when not in use (includes employee training and signage)			×			
Access Roads and Parking Areas:						
Ensuring paved surfaces	×	×	×			
Street sweeping as necessary	×	×	×			
Using dust suppressants on unpaved surfaces where necessary ($CaCl_2$, water)			×			
Interim Landfill Gas Collection and Control in Active Cell of Landfill:						
Using temporary flares or other gas collection systems			×	×		

(continued)

Table 2. MassDEP Approved BMPs for Landfills

(MSW Landfills, Ash Landfills, and C&D Landfills)

	Areas of Concern for Potential Risk					
MADEP Approved BMPs	Groundwater	Surface Water	Air Quality	Fire Protection	Insect/Rodent	
Water Quality Controls:						
Collecting water runoff from paved areas	×	×				
Using oil/water separators	×	×				
Using above ground leachate storage tanks	×	×				
Ensuring available potable water source for immediate use in case of fire or other emergency at the facility				×		
Storm Water/Erosion Controls:						
Implementing applicable storm water regulations and guidance by the Bureau of Resource Protection	×	×				
Using vegetation, wood chips, erosion control mats or other means to minimize erosion from the site	×	×				
Wheel washing in an area using secondary containment measures	×	×	×			
Other:						
Providing documentation that facility owners/operators have received formal training and have been certified as a landfill operator (certification can be received through national professonal programs)	×	×	×	×	×	
Establishing an odor complaint response plan						

* Retrofit devices should include only California Air Resources Board (CARB), US Environmental Protection Agency (EPA), or New England States for Coordinated Air Use Management (NESCAUM) certified retrofit devices.

Table 3. MassDEP Approved BMPs for Waste Handling Facilities

(Transfer Stations, C&D Processing Facilities, and Other Waste Handling Facilities)

MADEP Approved BMPs	Areas of Concern for Potential Risk					
	Groundwater	Surface Water	Air Quality	Fire Protection	Insect/Rodent	
For Any Waste Handling Facility:						
Diesel Emission Controls:						
Replacing old diesel equipment with new, lower emission diesel equipment			×			
Using electrically powered motors			×			
* Retrofitting ninety percent (90%) of all 1997 and older diesel engines used wholly or partially on site for more than 10 hours per week			×			
Replacing diesel powered equipment with compressed natural gas, liquid natural gas or liquid petroleum gas equipment			×			
For off-road engines, using only cleaner on-road diesel fuel			×			
For on-road engines, using only cleaner ultra low sulfur diesel fuel			×			
Minimizing idling of equipment by turning off engines when not in use (includes employee training and signage)			×			
Access Road and Parking Areas						
Ensuring paved surfaces for access roads, handling areas	×	×	×			
Street Sweeping as necessary	×	×	×			
Conveyor Systems:						
Using completely enclosed conveyor belts for materials that may blow around or result in dust nuisances			×			
Stockpile or Storage Areas:						
Storing materials in a building or 3-sided covered storage bunkers	×	×	×	×		
Street sweeping as necessary	×	×	×			
Ensuring paved surfaces	×	×	×			
Using water misting systems			×	×		
Water Quality Controls:						
Ensuring available potable water source for immediate use in case of fire or other emergency at the facility				×		
Using oil/water separators	×					
Using secondary containment around storage areas and truck washing areas	×	×				

(continued)

Table 3. MassDEP Approved BMPs for Waste Handling Facilities

(Transfer Stations, C&D Processing Facilities, and Other Waste Handling Facilities)

	Areas of Concern for Potential Risk					
MADEP Approved BMPs	Groundwater	Surface Water	Air Quality	Fire Protection	Insect/Rodent	
For Any Waste Handling Facility:						
Storm Water/Erosion Controls:						
Implementing applicable stormwater regulations and guidance by the Bureau of Resource Protection	×	×				
Using vegetation, wood chips, erosion control mats or other means to minimize erosion from the site	×	×				
Wheel washing in an area using secondary containment measures	×	×	×			
For Small Compactor Unit-Type Transfer Stations:						
Using a 3-sided shed roof over the hopper into which waste is dumped to control litter and keep rain from entering waste	×	×				
For Large Transfer Stations, C&D Processing Facilities, and Other Waste Handling Facilities:						
General BMPs						
Fully enclosed building and waste handling areas	×	×	×	×	×	
Using automatic doors and secondary enclosures (hanging plastic "curtains") at doors			×			
Using a negative air pressure system that includes fans and filters			×			
Requiring that all waste deliveries entering or exiting the facility be covered		×	×	×	×	
Using sealed containers for delivery of potential odiferous materials (e.g., food waste, processed organic wastes, sludges)			×		×	
Sealing and screening opening which may allow insects and rodents to enter the building					×	
Using a water misting system within the waste unloading areas			×	×		
Noise Controls:						
Noise survey before and after construction			×			
Installing noise attenuation plantings or structures (includes installing screening/barriers such as trees, berms, or walls around the facility to block and absorb facility noise. The installation of vegetative barriers such as trees can also help absorb and disperse potential odors from the facility.)			×			
Using wing walls and concrete structures, rather than metal structures, to help block noise			×			

(continued)

Table 3. MassDEP Approved BMPs for Waste Handling Facilities
(Transfer Stations, C&D Processing Facilities, and Other Waste Handling Facilities)

	Areas of Concern for Potential Risk					
MADEP Approved BMPs	Groundwater	Surface Water	Air Quality	Fire Protection	Insect/Rodent	
For Large Transfer Stations, C&D Processing Facilities, and Other Waste Handling Facilities:						
Noise Controls:						
Using controls on exhaust equipment			×			
Orienting transfer building openings away from receptors			×			
Using enclosures for loud equipment			×			
Air Pollution:						
Using enhanced air pollution controls when dust and odors cannot be adequately contained through other measures as determined by DEP			×			
Using a biofilter			×			

* Retrofit devices should include only California Air Resources Board (CARB), US Environmental Protection Agency (EPA), or New England States for Coordinated Air Use Management (NESCAUM) certified retrofit devices.

2.2 Assessment Appropriate To Facility Type

Facilities fulfilling the criteria for a Level 1 assessment should conduct a qualitative impact assessment. Facilities fulfilling the criteria for a Level 2 assessment should conduct a quantitative impact assessment. All facilities must initially meet all facility and siting criteria in accordance with the Site Assignment Regulations (310 CMR 16.00) (see Table 1) before conducting an impact assessment. Facilities requiring Level 1 and Level 2 assessments are discussed in more detail below.

2.2.1 Waste-Handling Facilities of Any Size

All facilities that handle/process waste and dispose of it off-site are encouraged to implement BMPs as discussed above prior to conducting an impact assessment. If a facility[10] has in place both acceptable BMPs for dust and odors and a plan to use low-emission diesel equipment on site, and the capacity of the proposed facility or expansion is less than 150 tons per day, MassDEP would likely issue a positive site suitability report without additional investigation and mitigation.

If either of the conditions described above are not met (i.e., if the facility has a proposed capacity greater than 150 tons per day **or** does not commit to the use of BMPs), MassDEP will evaluate the proposal and make a final site suitability determination as specified in the Qualitative Impact Assessment, Section 3.

[10] Provided that the facility will meet all applicable regulatory requirements.

If the facility does not propose use of BMPs including the use of low-emission diesel equipment on site **and** the capacity of the proposed facility or expansion is greater than 150 tons per day, the applicant should compile information from the SSEIS database on emissions from VOC sources within one mile of the facility perimeter as an indicator of industrial activity in the area. For proposed expansions, VOC totals should include emissions from the existing solid waste facilities registered in SSEIS within one mile of the facility being expanded. If total potential VOC emissions within a one-mile radius exceed 50 tons per year, MassDEP will likely issue a negative site suitability report. If total potential VOC emissions do not exceed 50 tons per year, MassDEP will base its site suitability decision on other facility-specific and site-related factors as specified in the Qualitative Impact Assessment section (Section 3 below).

2.2.2 Small Landfills That Take in Less Than or Equal to 150 Tons Per Day

Small landfills or expansions proposing to take in less than or equal to 150 tons per day do not need to conduct a Level 2 quantitative impact assessment. Such facilities will be evaluated largely in terms of the extent to which BMPs are proposed. If a proposed small landfill (that will meet all applicable regulatory requirements) commits to use BMPs for dust and odors as well as low-emission diesel equipment for on-site equipment to be used at the new facility or expansion and this proposal is acceptable to MassDEP, MassDEP would grant that facility a positive site suitability report.

If BMPs and the use of low-emission diesel equipment are not proposed for the facility, MassDEP will base its site suitability decisions on those factors specified in the Qualitative Impact Assessment section (Section 3).

2.2.3 New Landfills and Expansions That Take in Greater Than 150 Tons Per Day

All applications for landfills that take in greater than 150 tons per day of refuse should conduct a Level 2 quantitative impact assessment as part of the application process. The results of the quantitative impact assessment, including estimated facility-specific cancer and non-cancer risks from air emissions, will be considered in the context of total SSEIS VOC emissions from all point sources located within one mile of the perimeter of the proposed facility, unless determined otherwise by MassDEP. (VOC totals should include emissions from the existing solid waste facilities registered in SSEIS within one mile of the landfill being expanded.) MassDEP guidance for conducting a quantitative impact assessment is contained in Section 4 of this document.

MassDEP will evaluate this information in accordance with its quantitative risk management criteria specified in Section 4.6 of this document. Specifically, MassDEP will consider the totality of the information, including the acceptability of any proposed BMPs and SSEIS VOC emissions information.

SECTION 3: Qualitative Impact Assessment

MassDEP uses information on the type and capacity of the proposed facility, the extent of proposed use of BMPs, and VOC emissions information from facilities within one mile of the proposed facility to categorize proposals regarding level of assessment.

As the approach specified in Figure 1 indicates, for facilities requiring a Level 1 assessment, there are scenarios for which a site suitability determination can be clearly made based on this information alone. For example, if a waste-handling facility has a capacity less than 150 tons per day and proposes BMPs that are acceptable to MassDEP (i.e., ones that will effectively control emissions and resulting impacts) MassDEP will likely issue a positive site suitability report for the facility. If a waste-handling facility has a capacity greater than 150 tons per day, does not propose to use BMPs and is in an area where VOC emissions from adjacent facilities are greater than 50 tons per year, MassDEP may issue a negative site suitability report. This determination is based on the premise that additional emissions from a large facility in an area that already has significant emission sources could present an unacceptable additional public health burden to the surrounding community (however, the facility proponent may request a reconsideration of the negative finding).

There are a number of assessment scenarios under a Level 1 qualitative impact assessment that are not as clear-cut with regard to making a site suitability decision. In these cases, MassDEP evaluates the totality of the above information in the context of additional facility-specific and site-related factors. Tables 4 and 5 summarize the factors MassDEP will consider in qualitative impact assessments for making site suitability decisions. The factors may include but are not limited to:

- the extent to which BMPs are proposed;
- the type of land uses impacted by the facility;
- emissions of volatile organic compounds from other sources within the area; and
- particulate matter sources, such as solid waste management facilities, junk yards, auto salvage shops, bus and truck depots, etc. within the area.

For landfills with a capacity of less than 150 tons per day, the facility proponent should evaluate groundwater and surface water quality relative to water quality standards in applicable laws and regulations. If indicated by the assessment, the proponent must commit to develop and implement a cleanup plan to achieve compliance with these standards. See Appendix B – Guidance for the Assessment of Groundwater and Surface Water for Solid Waste Facility Site Assignment and Permitting in Support of 310 CMR 16.00 & 19.000.

Table 4. Level 1 Qualitative Impact Assessment - Waste Handling Facilities

For the following facilities (new or expansion):
- **Transfer stations**
- **C&D Processing facilities**

Size	Has the applicant proposed BMPs?	What are emissions from adjacent sources?	MassDEP's likely response will be:
< 150 tons/day	Yes	Not Required	Positive Report
	No	< 50 TPY VOCs	Evaluate: +/- Report
	No	> 50 TPY VOCs	Evaluate: +/- Report
> 150 tons/day	Yes	< 50 TPY VOCs	Evaluate: +/- Report
	Yes	> 50 TPY VOCs	Evaluate: +/- Report
	No	< 50 TPY VOCs	Evaluate +/- Report
	No	> 50 TPY VOCs	Negative Report

Table 5. Level 1 Qualitative Impact Assessment - Small Landfills

For the following facilities (new or expansion) <150 TPD:
- **MSW landfills**
- **Residuals (e.g. ash, special wastes) landfills**
- **C&D landfills**

Has the applicant proposed BMPs?	Do adjacent sources need to be considered?	Do other solid waste facilities need to be considered?	Results of Water Resources Assessment[1]	MassDEP's likely response will be:
Yes	No, Not Necessary	Consideration Not Necessary	Adequate	Positive Report
			Inadequate	Negative Report
No	Yes, Amount of VOCs Emitted	Yes, Amount of VOCs Emitted	Adequate	Evaluate: +/- Report
			Inadequate	Negative Report

[1]Assessment includes the water assessment and any applicable cleanup plan.

SECTION 4: Quantitative Impact Assessment

The Level 2 quantitative impact assessment protocol described in this document is designed to produce quantitative estimates of risk for a proposed landfill or expansion for both non-cancer and cancer effects. The methodology outlined below follows the risk assessment procedures of the National Academy of Science and builds upon existing risk assessment methods that MassDEP has established for assessment of contaminated sites as governed by the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000.

The risk assessment process consists of five steps. These include Hazard Identification, Dose-Response Assessment, Exposure Assessment, Risk Characterization and Uncertainty Analysis.

Hazard Identification determines whether a substance causes adverse effects and identifies those effects. A list of chemicals that are known to be or proposed to be emitted from a facility, along with their associated health effects, is compiled. Chemicals that are known or suspected to pose adverse health effects are identified as Contaminants of Concern (COC).

The **Dose-Response Assessment** describes the relationship between the level of exposure and the likelihood and severity of the adverse effects of the COC. Available toxicity values from USEPA or other sources are identified which quantify the concentrations or doses of chemicals associated with particular non-cancer or cancer endpoints.

The **Exposure Assessment** identifies potential routes of exposure, the populations exposed, the frequency, duration and extent of exposure to the COC, and quantitative estimates of exposure.

The **Risk Characterization** combines information from the first three steps to estimate the magnitude of the non-cancer and cancer health risks associated with exposure to the chemicals. The results of the quantitative risk assessment are compared to the risk management criteria established by MassDEP.

The **Uncertainty Analysis** identifies the uncertainty and variability inherent in the risk assessment due to the limitations in data quality and quantity and discusses the variability in the range of responses associated with the human population.

It is important to remember that risk estimates generated in the risk assessment are not precise measures of absolute risks. Rather, risk assessment is a tool, a method of providing valuable information regarding potential risks to public health. The risk assessment process outlined above is discussed in more detail below.

4.1 Hazard Identification – Contaminants of Concern (COC)

In the Hazard Identification step of a risk assessment, a preliminary list of chemicals that are likely to be emitted from the proposed facility under study is compiled. Information obtained from the solid waste literature addressing the type of facility under study as well as facility-specific air monitoring studies or modeling exercises are used to develop a list of COC.

The assessment will be based on the type of wastes that the facility will handle. The hazards associated with each chemical that has been selected as a COC should be described as well in the form of toxicity profiles. This information is used to identify the nature of adverse health effects associated with exposure to particular contaminants (Section 4.1.4) and whether the adverse health effect is likely to occur in humans.

MassDEP provides a default list of COC in this Guidance Document for municipal solid waste landfills, for which the quantitative risk assessment should include, at a minimum, the subset of AP-42 chemicals, as identified in Table 6 of this document. If the municipal solid waste landfill proposes to take in special wastes in an amount greater than fifty percent of the total yearly waste tonnage taken in by that facility, then MassDEP should be contacted to discuss inclusion of additional chemicals.

For ash and C&D landfills a quantitative risk assessment of potential air emissions is not needed. At ash landfills, MassDEP has determined that fugitive particulates associated with disposal activities are the emissions of most concern at these facilities and can be controlled by implementing BMPs pertaining to that type of facility. The results of an air monitoring study showed that entrainment to air of fugitive particles from ash is negligible if that ash is maintained at a high moisture content and if BMPs for dust control are implemented and maintained during generation and disposal activities of ash[11]. For C&D landfills, fugitive particulates can be similarly addressed by implementing and maintaining BMPs for dust control. In addition to particulate emissions, landfills that accept C&D waste, fines, or residuals may need to address hydrogen sulfide emissions.

Identification of COC for the various types of solid waste management facilities is discussed in the following sections.

[11] "Quantitative Impact Assessment (Risk Assessment) Supplemental Information Request" for the Ward Hill Neck Landfill in Haverhill, Camp, Dresser & McKee, October 2002.

Table 6. List of Landfill AP-42 Chemicals

1,1,1-Trichloroethane (HAP)	Carbonyl Sulfide (HAP/VOC)	Fluorotrichloromethane (VOC)
1,1,2,2-Tetrachloroethane (HAP/VOC)	Chlorobenzene (HAP/VOC)	Hexane (HAP/VOC)
1,1,2-Trichloroethane (HAP/VOC)	Chlorodifluoromethane (VOC)	Hydrogen Sulfide
1,1-Dichloroethane (HAP/VOC)	Chloroethane (HAP/VOC)	Mercury (HAP)
1,1-Dichloroethene (HAP/VOC)	Chloroform (HAP/VOC)	Methyl Ethyl Ketone (HAP/VOC)
1,2-Dichloroethane (HAP/VOC)	Chloromethane (HAP/VOC)	Methyl Isobutyl Ketone (HAP/VOC)
1,2-Dichloropropane (HAP/VOC)	Dichlorobenzene (VOC/HAP for 1,4-isomer)	Methyl Mercaptan (VOC)
2-Propanol (VOC)	Dichlorodifluoromethane (VOC)	Pentane (VOC)
Acetone	Dichlorofluoromethane (VOC)	Perchloroethylene (HAP/VOC)
Acrylonitrile (HAP/VOC)	Dichloromethane (HAP)	Propane (VOC)
Benzene (HAP/VOC)	Dimethyl Sulfide (VOC)	Toluene (HAP/VOC)
Bromodichloromethane (VOC)	Ethane	Trichloroethene (HAP/VOC)
Butane (VOC)	Ethanol (VOC)	t-1,2-Dichloroethene
Carbon Disulfide (HAP/VOC)	Ethylbenzene (HAP/VOC)	Vinyl chloride (HAP/VOC)
+Carbon Monoxide	Ethyl Mercaptan (VOC)	Xylene (HAP/VOC)
Carbon Tetrachloride (HAP/VOC)	Ethylene Dibromide (HAP/VOC)	

+This compound should be evaluated under 310 CMR 16.00.

4.1.1 Proposed Landfills

A site assignment request for a proposed landfill (greater than 150 tons per day) can represent either a totally new siting request or a request for an expansion to an existing facility. Both types of requests require that a quantitative impact assessment be conducted as part of the application for a site suitability determination or permit. A proposed expansion may have the advantage of use of emissions monitoring at the existing part of the facility to help identify potential COC in the proposed expansion, an option for which MassDEP approval is needed. However, given that the types of chemicals emitted from a landfill may differ depending on the stage of the decomposition process, emissions data from an existing landfill should not form the sole basis for identifying COC. While the results of such monitoring could be useful in terms of identifying compounds that may be unique to that landfill, it should not be assumed that these results are completely representative of the future emissions from the proposed expansion. An existing landfill is further along in the decomposition process than is the expansion and the landfill gas constituents released at that time are a function of the type of refuse that it has received over time as well as the rate and stage of biodegradation. The proposed expansion area may possibly receive a different mix of refuse, either by design or as a result of changes in the consumer waste stream over time. However, given the fact that an expansion may receive a waste stream somewhat similar to the existing landfill and that it shares the same geological and climatological characteristics, it is likely that at least some of the landfill gas constituents may be the same.

As discussed above, the risk assessment for municipal solid waste landfills should, at a minimum, include the list of AP-42 COC provided in this document pertinent to that type of landfill. In addition, a facility that takes in a special waste or wastes in an amount greater than fifty percent of the total annual waste tonnage taken in by that facility, should consider any additional potential emissions associated with the special waste. In such cases, the proponent should, with MassDEP approval, identify any additional COC beyond the MassDEP list. Prior MassDEP approval is also needed for all proposed protocols for identifying COC at non-municipal solid waste landfills.

Emissions from landfills to the ambient air may occur as both area sources and point sources. Landfill gas generated over the surface of the entire landfill as a result of decomposition is considered an area source. Point sources include landfill flares or stacks in which collected landfill gas is directly emitted or undergoes combustion. An uncontrolled landfill is only characterized by area sources. The following sections summarize the various types of landfill emissions and provide guidance on the selection of COC for both area and point emission sources.

4.1.1.1 Types of Landfills

As discussed in Section 2.2.3, all large landfills and expansions with a capacity to receive greater than 150 tons per day of refuse should conduct a quantitative impact assessment as part of the application process for a site suitability request or a permit to construct if expanding into a previously site assigned parcel of land for which a quantitative impact assessment was not done. The types of landfills covered by this assessment include municipal solid waste (MSW) facilities,

C&D facilities, and facilities that take in special wastes in an amount exceeding fifty percent of the total waste taken in by that facility.

Landfill gas emissions from on-site disposal of these wastes will occur for many years after closure of the landfill. The USEPA has developed a model that allows for the temporal characterization of landfill gas emissions from MSW facilities. MassDEP's recommended approach for modeling and assessing landfill gas emissions is addressed below.

Non-municipal waste facilities are less general and accept a specific type of waste. For example, residuals facilities may accept municipal solid waste incinerator ash and C&D landfills may accept construction and demolition waste. MassDEP believes that one of the emissions of concern from non-MSW facilities is fugitive particulates generated during transport and processing of these wastes. The characterization of fugitive particulate emissions from landfills is limited, although total emission generation and modeling methods do exist. MassDEP will entertain proposals on a case-by-case basis for chemically characterizing, modeling and assessing fugitive particulate emissions and potential health risks from landfills. Additional discussion on the recommended protocol for these proposals is addressed below. In addition to particulate emissions, landfills that accept C&D waste, fines, or residuals may need to address hydrogen sulfide emissions.

4.1.1.1.1 COC in Landfill Gas from Municipal Solid Waste Facilities

Landfill Area Sources

Landfill Gas Constituents

Landfill gas is generated as a by-product of the anaerobic biodegradation of refuse in landfills. The predominant landfill gases include methane and carbon dioxide, with much smaller amounts of non-methane organic compounds (NMOC). As methane and carbon dioxide are released from decaying refuse, these gases pass through the landfill, sweeping NMOC and other air pollutants present in the refuse to the surface.

NMOC include volatile organic compounds and other air pollutants. USEPA defines air pollutants as compounds found in landfill gas or emitted with landfill gas, some of which are listed as air pollutants under Section 112 of the Clean Air Act.

Reduced sulfur compounds represent the sulfur-containing fraction of landfill gas. Although these compounds comprise a relatively small fraction of landfill gas, because of their characteristic odors, they are often the most evident components. Reduced sulfur compounds are a common reason for odor complaints from the public.

USEPA has concluded that a number of compounds found in landfill gas cause, or contribute significantly, to air pollution that may reasonably be anticipated to endanger public health or welfare. Some NMOCs are known to have carcinogenic or non-carcinogenic health effects. Methane is of concern primarily because of its explosive potential and as a greenhouse gas that contributes to global warming. Public welfare concerns include the odor nuisance from certain landfill gas constituents such as sulfur compounds, and the concern for migration of

methane, producing the potential for explosions or fire. It is assumed that landfill gas can be emitted anywhere in the landfill and, as such, is considered to be an area source (USEPA, 1998).

AP-42 Chemicals

The list of chemicals commonly referred to as the "AP-42 chemicals" was developed by USEPA. This list identifies a number of air pollutants expected to be emitted from landfills based on test data USEPA compiled in a document entitled *Compilation of Air Pollutant Emission Factors, AP-42* (USEPA, 1997a). This information was collected by USEPA in an extensive search of the literature, electronic databases, and USEPA resources, including municipal solid waste landfill testing reports. The data were then reviewed and reduced to produce the AP-42 list, a list of 47 chemicals found to be emitted from landfills. The list of AP-42 compounds is in Table 6 of this document. USEPA incorporated this same list of AP-42 chemicals into the Landfill Gas Emissions Model (LandGEM). LandGEM models the emission rates of the 47 chemicals of concern with respect to the landfill site and/or from controlled and uncontrolled vents. MassDEP has reviewed the list of AP-42 chemicals and has identified sufficient toxicity information to evaluate quantitatively all but a handful of the chemicals (Table 7). One criteria pollutant on this list, carbon monoxide, is evaluated elsewhere under 310 CMR 16.00 and is not addressed in the risk assessment. As additional toxicity data for the chemicals without currently published values become available, they should also be included in quantitative risk assessments.

The AP-42 chemicals represent a good starting point for predicting and evaluating potential emissions from a facility that is still in the design phase. MassDEP considers the AP-42 chemicals as the most comprehensive database on landfill gas emissions currently available in the landfill literature. Therefore, all quantitative risk assessments done in support of a landfill site assignment request should, at a minimum, consider the list of AP-42 chemicals as COC. If a proponent prefers to use facility-specific monitoring data to characterize emissions at the facility being evaluated, the proponent may do so. However, this information should only be used to supplement the list of AP-42, not delete from it.

In the case of landfills that also accept special waste (i.e., a waste for which a special waste permit is needed) in an amount greater than fifty percent of its total annual waste intake, the proponent should evaluate the potential of the special waste to result in emissions of additional chemicals other than those on the AP-42 list. MassDEP review and approval of such assessments is required. See section on "Special Wastes" below.

Other Chemicals

MassDEP will entertain proposals on a case-by-case basis for identifying additional COC, including for example, based on collecting monitoring data from a similar facility. For landfill expansion requests, such a proposal could include monitoring at the existing landfill assuming it receives the same waste stream.

It should be noted that since landfill emissions are also a function of the stage of decomposition, this parameter should also be addressed when identifying COC. As discussed

previously in this document, since it is very difficult to determine at what point along a gas production curve a set of monitoring data may have been derived, MassDEP's policy regarding this issue is that, at a minimum, the list of AP-42 COC should be used along with, for each chemical, the higher of the AP-42 concentration or the monitored concentration as an estimate of a worst-case concentration. The list of COC can be supplemented with additional chemicals but chemicals should not be deleted from the list.

The USEPA has established a number of promulgated test methods for measuring air emissions which can be found on the internet at the Technology Transfer Network (TTN) Emission Measurement Center (EMC) of USEPA's website at http://www.epa.gov/ttnemc01/promgate.html. Monitoring plans submitted by the applicant should be comprehensive and include a protocol for identifying tentatively identified compounds (TICs) as well a quality assurance/quality control (QA/QC) plan.

Special Wastes

A special waste or combination of special wastes should be addressed in a quantitative risk assessment if that waste comprises greater than fifty percent per year of the total waste taken in at a facility. If the percentage of special waste is equal to or below fifty percent of the total yearly waste tonnage, then a quantitative assessment of emissions from the special waste is not required. However, the proponent must comply with all existing MassDEP regulations and permit requirements governing special wastes as provided for in 310 CMR 19.000. In addition, the proponent should document their yearly projection of special waste tonnage and describe how this quantitative estimate is determined. If the percentage of a particular waste is projected to be greater than fifty percent at any time during a facility's lifetime, then the potential emissions from special wastes should be included in the risk assessment. In such situations, the list of AP-42 COC identified for inclusion in the quantitative risk assessment for a landfill siting or permitting request should be supplemented with additional chemicals predicted to be emitted based on the special wastes of concern. All such chemicals for which toxicity data exist should be included in the impact assessment.

As discussed above, quantitative information on potential emissions can be obtained in several ways. Applicants may be required to identify from the peer-reviewed literature additional COC, subject to MassDEP approval, predicted to be released from special wastes. These data should be obtained from reputable emissions studies conducted at similar facilities. Information about the chemical and physical properties of the special wastes as they relate to the decomposition process can also be used.

Alternatively, as discussed in the previous section, MassDEP will entertain proposals on a case-by-case basis for identifying additional chemicals based on collecting monitoring data from a similar facility taking in the same type of special wastes. For landfill expansion requests, such a proposal could include monitoring at the existing landfill assuming it processes the particular special waste of concern.

Table 7. Toxicity Information for the AP-42 List of Chemicals

Toxicity Information (Always check for updated toxicity information) Chemical	CAS	SubChronic Reference Concentration RfC mg/m3	ref	Chronic Reference Concentration RfC mg/m3	ref	Inhalation Unit Risk Value URinh (µg/m3)-1	USEPA Cancer Classification	re
1,1,1-Trichloroethane (methyl chloroform)	71-55-6	1.00E+01	2b	5.20E+00	3a		D	
1,1,2,2-Tetrachloroethane	79-34-5	2.80E+00	10	9.30E-02	3a	5.80E-05	C	1
1,1,2-Trichloroethane	79-00-5	7.40E-02	6	7.40E-02	3a	1.60E-05	C	1
1,1-Dichloroethane (ethylidene dichloride)	75-34-3	5.00E+00	2	5.00E-01	2	1.60E-06	C	5
1,1-Dichloroethene (vinylidene chloride)	75-35-4	8.10E-02	10	2.00E-01	1		C	
1,2-Dichloroethane (ethylene dichloride)	107-06-2	5.50E-02	6	5.50E-02	3a	2.60E-05	B2	1
1,2-Dichloropropane (propylene dichloride)	78-87-5	1.30E-02	2	4.00E-03	1	1.90E-05	B2	3b
2-Propanol (isopropyl alcohol)	67-63-0							
Acetone	67-64-1	3.10E+01	10	8.00E-01	3a		D	
Acrylonitrile	107-13-1	2.00E-03	6	2.00E-03	1	6.80E-05	B1	1
Benzene	71-43-2	3.20E-02	4	9.00E-03	3a	7.80E-06	A	1
Bromodichloromethane	75-27-4							
Butane	106-97-8	4.50E+00	6	9.50E-01	11			
Carbon disulfide	75-15-0	7.00E-01	2	7.00E-01	1		NA	
Carbon monoxide								
Carbon tetrachloride	56-23-5	4.30E-01	6	4.30E-01	3a	1.50E-05	B2	1
Carbonyl sulfide	463-58-1	5.00E-04	6	5.00E-04	3a			
Chlorobenzene	108-90-7	2.00E-01	2b	6.00E-02	7		D	
Chlorodifluoromethane	75-45-6	5.00E+01	6	5.00E+01	1			
Chloroethane (ethyl chloride)	75-00-3	1.00E+01	2	1.00E+01	1			
Chloroform	67-66-3	6.60E-01	6	6.60E-01	3a	2.30E-05	B2	1
Chloromethane (methyl chloride)	74-87-3	4.20E-01	10	3.00E-01	7	1.80E-06	C	2
Dichlorobenzene (tox data for para)-	106-46-7	1.20E+00	10	8.00E-01	1	6.90E-06	C	2a
Dichlorodifluoromethane	75-71-8	2.00E+00	2	2.00E-01	2			
Dichlorofluoromethane	75-43-4							
Dichloromethane (methylene chloride)	75-09-2	3.00E+00	2	3.00E+00	2	4.70E-07	B2	1
Dimethyl sulfide (methyl sulfide)	75-18-3							
Ethane	74-84-0	4.50E+00	6	9.50E-01	11			
Ethanol	64-17-5	2.50E-01	6	2.50E-01	3a			
Ethylbenzene	100-41-4	1.00E+00	2b	1.00E+00	1		D	
Ethyl mercaptan (ethanethiol)	75-08-1							
Ethylene dibromide (dibromoethane)	106-93-4	2.00E-03	2	2.00E-04	2	2.20E-04	B2	1
Fluorotrichloromethane	75-69-4	7.00E+00	2	7.00E-01	2			
Hexane	110-54-3	2.00E-01	2	2.00E-01	1			
Hydrogen sulfide	7783--06-4	1.00E-02	2	1.00E-03	1		NA	
Mercury, total (tox data for elemental)	7439-97-6	3.00E-04	2	3.00E-04	1		D	
Methyl ethyl ketone	78-93-3	1.00E+00	2	1.00E+00	1		D	
Methyl isobutyl ketone	108-10-1	8.00E-01	2	8.00E-02	2		NA	
Methyl mercaptan	74-93-1	2.50E-03	6	2.00E-03	9		NA	
Pentane	109-66-0	2.00E-01	6	2.00E-01	8			
Perchloroethylene	127-18-4	4.60E+00	6	4.60E+00	3a	5.50E-05	NA	3b
Propane	74-98-6	2.00E-01	6	9.50E-01	11			
Toluene	108-88-3	4.00E-01	2b	4.00E-01	1			
Trichloroethylene	79-01-6	5.50E-01	10	1.80E-01	3	1.70E-06	NA	2b
t-1,2-Dichloroethene	156-60-5	8.10E-01	10	1.10E+00	3a		NA	
Vinyl chloride	75-01-4	1.00E-01	6	1.00E-01	1	8.80E-06	A	1
Xylenes (m-, o-, p-)	1330-20-7	3.10E+00	10	6.00E-02	3a		D	

References for Table 7

1. USEPA Integrated Risk Information System (IRIS)
2. USEPA Health Effects Assessment Summary Tables (HEAST)
2.a Converted from the oral slope factor listed in HEAST
2.b Withdrawn from HEAST pending EPA review
3.a MassDEP – Back-calculated from the MassDEP Threshold Effects Exposure Limits
3.b MassDEP – From the Chemical Health Effects Assessment Methodology and the Method to Derive

Allowable Ambient Limits (CHEM/AAL)
4. MassDEP – Calculated Value
5. California EPA
6. This chronic value should be used to evaluate subchronic exposures in the absence of a subchronic RfC.
7. Provisional value, USEPA National Center for Environmental Assessment
8. Toxicity values for hexane are used to evaluate this alkane.
9. US EPA Risk Assessment Information System (RAIS)
10. Agency for Toxic Substances and Disease Registry (ATSDR)
11. Calculated using the MassDEP CHEM/AAL process from the NIOSH occupational limit for butane. This value should also be used to evaluate ethane and propane.

Landfill Point Sources

Stack Gas Constituents

Gas collection systems can be either active or passive. Active systems employ pressure gradient using mechanical blowers or compressors whereas passive systems rely on the natural pressure gradients created as landfill gas builds up to mobilize the landfill gas. The design of collection systems varies with landfill characteristics and operation. Some involve installation of probes at the landfill perimeter, although the probes are generally installed directly within the refuse-containing area. In general, active systems are more efficient in collecting gas than are passive systems. Reported gas collection system efficiencies range from 60% to 85%, with an average of 75% most commonly assumed (USEPA, 1997d).

Control treatment of the collected gas can be done using either a combustion technology or a purification technique. Combustion technologies generally involve either flares, in which collected gas is destroyed via burning, or an energy recovery technique in which energy generated in the destruction of the gas is collected via gas turbines, boiler to steam turbines or internal combustion engines. Purification techniques generally involve use of adsorption, absorption and membrane techniques to remove water, carbon dioxide and NMOCs.

Flares use an open combustion process and represent point emission sources within a landfill. Flares may be open or enclosed. Enclosed flare systems can better control the quality of combustion by regulating temperature, residence time of components in the combustion zone, turbulent mixing within the combustion zone and the amount of oxygen available for combustion. A well-operating flare has a control efficiency of 90-99% for NMOC, 91-99% for halogenated species and 38-99% for non-halogenated species (USEPA, 1997d).

Based on the fact that collection and combustion of landfill gas is not one hundred percent efficient, constituents of landfill gas are still expected to be released from landfills with collection and treatment systems. These emissions can result from uncollected gas or non-combusted gas from control devices. In addition to landfill gas constituents, the flaring process produces secondary pollutants that are released at the stack. Secondary pollutants typically released from landfill flares include nitrogen oxides, carbon monoxide and particulate matter. Other pollutants may also be released, depending on the waste stream within that landfill. For example, when chlorinated compounds are combusted in control equipment, hydrogen chloride emissions are formed.

AP-42 Chemicals

As discussed above, although the total amount of landfill gas constituents is expected to decrease substantially with the use of collection and treatment systems, these chemicals are still expected to be released in controlled landfills. Thus, even for a controlled facility, all quantitative risk assessments done in support of a landfill expansion request should, at a minimum, include the list of AP-42 chemicals as COC or a MassDEP approved alternative list of COC's. See the section above on area sources for additional information on the AP-42 chemicals and options for identifying a list of COC at landfills.

Other Landfill Gas Chemicals

As discussed above, since chemicals emitted in landfill gas are a function of the waste stream received, it is possible that additional chemicals which are not on the AP-42 list may be emitted in the collected landfill gas, especially in the case of facilities that accept non-traditional wastes or special wastes. As stated above, even for a controlled facility, predicted emissions from such wastes, if they comprise greater than fifty percent of the total annual waste intake for that facility, should be included as COC. See above section on area sources for additional information on options for establishing COC for special wastes at landfills.

Secondary Pollutants from Stack Emissions

MassDEP may require on a case-by-case basis the identification of additional COC (e.g., hydrogen chloride) in stack emissions. These data may include well-conducted landfill flare emissions studies from the literature conducted at facilities accepting a similar waste stream. Additional stack gas constituents may also be predicted by analyzing the waste stream for that facility along with information on the chemical and physical properties of the chemicals predicted to be generated in landfill gas. Principles of combustion chemistry can be used to predict the combustion by-products generated upon flaring.

Alternatively, MassDEP may require on a case-by-case basis the identification of secondary COC based on collecting monitoring data from a similar facility. For requests involving landfill expansions at facilities with collection and treatment systems, such a proposal could include monitoring at the existing stack assuming the expansion will receive the same waste stream as the existing landfill. Information on USEPA promulgated test methods for measuring air emissions for a number of parameters can be found on the internet at the Technology Transfer Network (TTN) Emission Measurement Center (EMC) of USEPA's website at http://www.epa.gov/ttnemc01/promgate.html. Monitoring plans submitted by the applicant should be comprehensive and include a quality assurance/quality control (QA/QC) plan.

4.1.1.2 COC From Non-Municipal Solid Waste Landfills

For ash landfills and C&D landfills, MassDEP has determined that the emissions of most concern are fugitive particulates generated during transport and processing of these wastes, as well as hydrogen sulfide for C&D landfills. Particulates of health concern include those with a diameter less than 10 μm (PM10, PM2.5), in particular those less than 2.5 μm (PM2.5).

Toxicologically, it is the very small particulates that, once inhaled, can penetrate deep into the lung where they are not easily eliminated by the lung's clearance mechanism and can thus persist to do more damage. At each of these facilities, MassDEP believes that particulate emissions can be adequately controlled through use of facility-specific BMPs that address fugitive dust control. MassDEP is issuing guidance on addressing hydrogen sulfide emissions that will include recommendations on establishing monitoring systems, developing response plans, and facility operations and design.

Ash Landfills

Ash, and in particular, fly ash, consists of very fine particulates. For this reason, MassDEP had been concerned in the past about potential emissions of fugitive particulates from ash transport and disposal activities at landfills. Studies that look at the potential for entrainment into air of fugitive particles at ash landfills are limited. As a conservative approach, MassDEP therefore historically required that the potential emissions and resulting risks due to fugitive emissions from landfills be estimated and evaluated using the AP-42 approach. The AP-42 approach was used to generate an estimate of a dust emission rate to which percent metal composition data (measured in facility-specific ash) was applied to estimate metal concentrations in that ash.

MassDEP found that the assessments conducted using the AP-42 approach typically yielded very low estimates of risk, generally in the *de minimis* range. In the course of conducting these assessments, MassDEP also learned more about the ash-generation process and the nature of ash. Based on the required BMPs for ash, the ash-generating process typically yields a product of high moisture content. Ash is produced as the end product of the burning of organic materials (e.g., most typically, municipal solid waste, coal, etc.). Bottom ash is created when the residue from combustion falls into a water bath that cools the residue, thus saturating the bottom ash stream with water. Fly ash is typically mixed with water to increase its moisture content. Ash is hygroscopic and once dry forms a fairly rigid structure that does not easily break down into particles small enough to become airborne.

The preponderance of evidence demonstrates that ash disposal does not result in any significant entrainment of ash dust. In 2002, a field monitoring study (AMEC, 2002) was performed at the Ward Neck Landfill Expansion in Haverhill, Massachusetts for Covanta Haverhill Associates (hereafter referred to as the "Covanta report") to measure concentrations of fugitive emissions that might be associated with ash disposal activities. This investigation was undertaken by the proponents of this facility to address their contention that ash emissions associated with disposal activities were negligible and that the exposure assessment would be zero in a quantitative risk assessment. Both upwind and downwind concentrations of respirable particulates (PM10) were measured at this facility during ash disposal activities. It was found that downwind PM10 concentrations were slightly (although statistically significant) higher than upwind concentrations. However, additional observations strongly indicated increases in downwind PM10 were due to diesel exhaust from on-site equipment rather than from entrainment of ash. The observations included: PM10 concentrations were higher downwind during dry dumping runs (i.e., empty trucks simulating ash dumping); there were no significant differences between upwind and downwind metal concentrations during ash dumping activities.

Given that the moisture content of ash is the characteristic that prevents entrainment, protection against future dust generation after water has been added is assured because it is extremely difficult for ash to dry out.

Based on experiences to date and on the results of the Covanta study, MassDEP concludes that entrainment to air of fugitive particles from ash is negligible if that ash is maintained at a high moisture content (i.e., greater than 18% water content) during generation and disposal activities.

Thus, if proper BMPs that address fugitive dust control are implemented at a facility, there should be no need for an assessment of fugitive dust in a quantitative risk assessment. In addition, also based on findings of the Covanta study, BMPs should be put into place at facilities to retrofit existing on-site vehicles with diesel control technology and to limit idling times.

Construction and Demolition Landfills (C&D)

No chemical-specific, quantitative risk assessment is required for C&D landfills at this time. Fugitive particulates from C&D landfills are addressed in the assessment of the criteria pollutant PM10 that is required to be done elsewhere in the siting and permitting processes. As discussed above for ash landfills, MassDEP believes that fugitive emissions from C&D facilities may be adequately controlled by implementing BMPs that address control of fugitive dust.

However, MassDEP is issuing guidance to address hydrogen sulfide emissions from landfills that handle C&D waste, fines, or residuals. Based on this guidance, MassDEP may require additional controls or assessment for landfills that handle C&D waste, fines, or residuals.

4.1.2 Emissions From Proposed Waste Handling Facilities

Generally waste handling facilities should be characterized by a Level 1 assessment and emissions should be adequately controlled by BMPs. Waste handling facilities are those in which refuse is collected, processed and transported off-site. Facilities may either handle municipal trash such as municipal waste transfer stations, or they may specialize in a particular sector of the waste stream. Examples of more specialized waste handling facilities include construction and demolition facilities and facilities that recycle landscaping wastes. Often, these facilities exist because there is a market for materials recovered or recycled from the waste stream. Usually, these facilities are able to recover portions of the waste stream to be shipped off-site for reuse or recycling and the unrecoverable portion is transported off-site to another facility for disposal. The residence time of most wastes at waste handling facilities is transitory, since the waste enters the facility, is processed and is then shipped off-site.

The types of emissions generated from these facilities vary greatly depending on the nature of the refuse processed. Mixed waste collected in municipal transfer stations is similar in composition to municipal refuse that is landfilled. If these wastes were stored at the facility for an extended period of time during which the decomposition process could progress, the gases generated might be similar to those found at landfills. Since this is not the case and because of the transitory nature of the wastes passing through such facilities, MassDEP considers the

emissions of concern at waste handling facilities as those area emissions generated during processing, known as fugitive particulates.

Fugitive particulates that are generated and dispersed at a facility during day-to-day operations may be emitted in conjunction with the loading and unloading of refuse, packing and compacting operations, and other activities, especially in windy, dry conditions. However, waste handling facilities are not characterized by the fugitive dust associated with excavation, packing and landfill covering operations that are typical of landfills. Thus, emissions of fugitive particulates in a well-controlled waste handling facility are expected to be relatively low. MassDEP's protocol for evaluating site suitability of solid waste facilities encourages all facilities to install measures to control dusts utilizing Best Management Practices (BMPs). MassDEP expects that use of BMPs for dust control will address and significantly limit the emission of fugitive dusts from waste processing facilities.

4.1.3 Diesel Particulates

Diesel exhaust generated from heavy truck equipment and engines used at solid waste facilities contain large quantities of particulates and nitrogen oxides (NO_x) as well as other pollutants including hydrocarbons and several gases. In general, although diesel engines are more efficient than their gasoline-powered counterparts, current regulations allow them to emit far more pollutants.

Diesel particulates and NO_x at solid waste management facilities may be emitted from on-site equipment as well as from vehicles transporting refuse into and out of the facility. At landfills, heavy truck diesel equipment is used for excavating and moving dirt, for landfill covering and compacting operations as well as for waste transport. At waste handling facilities, diesel equipment is used to move, consolidate and compact trash before it is trucked or railed off-site. Diesel transport vehicles, which are used to haul refuse into and out of the facility will emit diesel particulates and NO_x during the relatively brief time they are visiting the facility. However, the number of trucks visiting a facility in any one day will influence the proportion of diesel pollutants contributed from truck traffic which could be quite significant, depending on the facility. On the other hand, there may be many fewer pieces of heavy duty diesel equipment on site and these may operate at a facility for hours at a time, constantly emitting diesel pollutants. Such equipment may even operate in enclosed facilities, resulting in substantial, localized exposure to workers.

Diesel particulates are very fine, most of which are characterized by a particle diameter less than 2.5 μm and therefore have the capacity to be inhaled deep into the lungs, where they can have adverse effects. Particulates produce eye and nose irritation and aggravate respiratory problems, including asthma. In addition, very fine particulates have been found to contribute to an increased risk of premature death. Diesel engines release particulates directly into the air, emit nitrogen oxides and sulfur oxides, which then transform into "secondary" particulates in the atmosphere.

NO_x lowers resistance to respiratory infections and aggravates symptoms associated with asthma and bronchitis. In addition, NO_x contributes to the formation of ozone (O_3), which irritates the respiratory system causing coughing and choking and reduced lung capacity.

To limit diesel emissions from proposed solid waste facilities, MassDEP strongly encourages that all on-site transport equipment used on all new and expanded landfills and new and expanded waste handling facilities be retrofitted with diesel control technology. Such retrofitting will significantly reduce on-site diesel emissions.

4.1.4 Toxicity Profiles

The descriptions of the potential health effects associated with each contaminant are typically provided in a Toxicity Profile. Toxicity Profiles serve several purposes. They provide a summary of the potential adverse human health effects that may be associated with exposure to a particular contaminant and they contain references for the dose-response assessment. The information in Toxicity Profiles may also be used to group chemicals by health endpoint and mechanism of toxicity in order to fine-tune risk estimates. In addition, toxicity profiles also serve as reference material for non-toxicologists who want to understand the potential health impacts associated with contaminants.

The scope and level of detail of a Toxicity Profile will vary depending upon the nature and quantity of information available for a particular chemical. For many substances, toxicological information is readily available from many sources, and repetition of that information in great detail in the Toxicity Profile is not necessary. For the purpose of the AP-42 chemicals evaluated in the quantitative risk assessment, a short descriptive summary of the known health effects associated with the chemicals of interest and the basis for any existing standards or guidelines would be sufficient. This information can be presented in the form of a table or brief text. At a minimum, the profile should summarize known chronic systemic toxicity, developmental/reproductive toxicity, genotoxicity and carcinogenicity. If additional chemicals have been identified, a more in-depth toxicological profile should be provided which also includes a profile of the toxicokinetics, human and animal mechanisms of toxicity, structure-activity relationships and interaction with other chemicals, as appropriate. In preparing the toxicity profile, the risk assessor should rely on credible, peer-reviewed sources of information such as controlled, epidemiologic investigations, clinical trials, experimental animal studies, metabolic and pharmacokinetic experiments, in vitro studies and structure-activity studies. All references should be provided to document the sources of information used to prepare the toxicity profile.

4.2 Dose-Response Assessment

The Dose-Response Assessment involves a compilation of toxicity information on the health effects of the COC. This information is obtained from human epidemiological or animal toxicology studies in the published literature. Dose-response information for a large number of compounds is represented in toxicity values published by the USEPA and other government agencies. Toxicity values are chemical- and route-specific values obtained from epidemiological or animal toxicity studies that have been adjusted to be applicable to chronic or subchronic exposures of the general population, including sensitive individuals. These types of values, which include non-threshold inhalation toxicity values and cancer unit risk values are generally used in health risk assessment to estimate the type and magnitude of risk associated with exposure to chemicals.

Toxicologically, there is believed to be an exposure level of a compound below which adverse health effects do not occur. Theoretically, health effects are only possible once that particular level of exposure or threshold is exceeded. Such a level is referred to as a threshold dose. In theory, the threshold dose would be safe for all receptors who might be exposed at that level. A brief summary of key toxicity values for use in quantitative impact assessments for proposed facilities is described below. MassDEP recommends assessment methods based on standard USEPA toxicity values and equations.

A threshold dose or exposure can be administered as an acute, subchronic or chronic exposure. Acute exposure is typically assumed to be up to 24 hours in duration (quantitative assessment of acute exposure is not required at this time). Subchronic exposures for humans refer to exposures up to seven years in duration, while a chronic time period is greater than seven years. Both subchronic and chronic exposures should be evaluated in the risk assessment for all chemicals in order to assess all relevant exposure scenarios. Subchronic and chronic subthreshold values should be used to evaluate subchronic and chronic exposures, respectively.

Non-Cancer

For the inhalation pathway, a subthreshold exposure for chronic exposures is represented by a Reference Concentration (RfC) (in units of mg/m^3). The RfC is the inhalation exposure concentration (with uncertainty spanning perhaps an order of magnitude or greater) to which daily exposure of a human population, including sensitive populations, is likely to be free of appreciable effects. Methods for development of inhalation reference concentrations are detailed by USEPA.

For the ingestion pathway, a Reference Dose (RfD) represents a subthreshold oral dose for chronic exposures (in units of mg/kg/day). The RfD is the dose (with uncertainty spanning perhaps an order of magnitude or greater) to which daily exposure of a human population, including sensitive subgroups, is likely to be free of appreciable effects during a lifetime. Methods for development of RfDs are similar to those used to develop RfCs. RfDs may be used to evaluate inhalation exposures of particulate-associated contaminants, typically evaluated in terms of dose rather than concentration. Additional discussion of the use of RfDs is found in the Exposure Assessment section of this document.

Cancer

Unlike threshold effects, with non-threshold effects it is assumed that every concentration or level of a compound, no matter how small, produces some effect. Carcinogenicity and mutagenicity are examples of non-threshold effects.

The dose-response assessment for carcinogens assumes that there is no threshold dose for carcinogenicity, or in other words, that there is no dose of a carcinogenic substance (other than no exposure) that is associated with zero risk. USEPA evaluates available toxicity data and assigns the chemical to a weight-of-evidence class.

For inhalation exposures, the ability of a chemical to increase the incidence of cancer in a target population is typically described by the cancer unit risk (UR) factor.

The Unit Risk is the upper 95% Confidence Limit of the mean incremental lifetime cancer risk estimated to result from lifetime exposure to a compound if it is in the air at a concentration of 1 $\mu g/m^3$. A Unit Risk is expressed as risk per concentration in air, typically given in units of $(\mu g/m^3)^{-1}$. Unit Risk values are issued from a number of different sources (See Section 4.2.2). Unit Risk values are multiplied by the concentration (in $\mu g/m^3$) of a compound in air to derive a unitless cancer risk estimate.

For the ingestion pathway, the measure of carcinogenic potency is described by a Cancer Slope Factor (CSF). CSFs are also issued from a number of different sources (See Section 4.2.2). The CSF for a chemical is calculated using mathematical extrapolation models, commonly the linear multistage model, from the dose-response curve of a toxicological study. The largest possible linear slope (within the 95% Confidence Limit) of this curve is estimated at low extrapolated doses. Although for some chemicals, human epidemiologic data are the basis of an estimate of the carcinogenic potency, the most common basis of these values is an animal study. The CSF is expressed as risk per unit dose, and is typically given in units of $(mg/kg/day)^{-1}$. Use of the slope factor assumes that the calculated dose received is expressed as a lifetime average. CSFs are multiplied by the ingested dose (in mg/kg/day) of a compound to derive a unitless cancer risk estimate. CSFs may be used to evaluate inhalation exposures of particulate-associated contaminants, typically evaluated in terms of dose rather than concentration. Additional discussion on the use of the CSF is found in the Exposure Assessment section of this document.

The dose-response assessment describes the observed effects in humans and/or laboratory animals associated with particular exposures or doses of the chemicals of concern. This information is obtained from published literature describing epidemiological or toxicological studies involving the particular chemical. For most chemicals included as COC in a solid waste facility impact assessment, the dose-response information needed to conduct a risk assessment may be found in secondary sources published by the USEPA or other government agencies, as described below.

The dose-response relationships for each COC should be identified in the risk assessment report. This information is later coupled with knowledge of the nature and magnitude of potential exposures to characterize risk.

The dose-response information used for risk assessment may be divided into three major categories:

- Toxicity information associated with threshold (non-carcinogenic) health effects
- Toxicity information concerning carcinogenicity, either from human epidemiologic data or from laboratory studies
- The Relative Absorption Factors (RAFs) used to relate the toxicity information identified from the literature to the exposure pathway of concern at the proposed site under investigation.

4.2.1 Conversions from Dose

In the absence of RfCs or Unit Risk values, an oral Reference Dose or Slope Factor may be used to estimate risk by converting the Reference Dose to a Reference Concentration and the Slope Factor to a Unit Risk if it is appropriate to do so based on toxicological considerations.

4.2.2 Sources of Dose-Response Values

There are a number of different sources of both subthreshold and non-threshold toxicity criteria. When selecting toxicity information for use in quantitative risk assessment, the project proponent should ensure that the information is appropriate for the assessment being conducted and that it is up-to-date. Note that sources differ in the frequency at which they are updated and level of review they receive.

Both threshold and non-threshold toxicity criteria are available from a variety of sources. These include (listed in general order of preference, although case-by-case exceptions may apply):

- **Integrated Risk Information System (IRIS) database -** This database contains values that represent a consensus judgment of the USEPA Carcinogen Risk Assessment Verification Endeavor (CRAVE), which is composed of scientists from various USEPA offices and the Office of Research and Development. It is the preferred source of toxicity information. The IRIS database is updated monthly and is available on the Internet. IRIS contains both chronic inhalation RfCs and RfDs, and unit risk factors. (http://www.epa.gov)

- **Health Effects Assessment Summary Tables (HEAST) -** HEAST contains values that have received some form of review by USEPA, but have not been verified and are considered provisional. HEAST is prepared by USEPA's Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. HEAST can be obtained by contacting the National Technical Information Service (NTIS) Subscriptions Department. HEAST contains both chronic RfCs and RfDs and unit risk factors.

- **Other Sources**

  non-cancer:

  - **Allowable Threshold Concentration (ATC) -** The "Allowable Threshold Concentrations" are similar to the USEPA inhalation RfCs in intent but they are derived by ORS using a modified version of the methodology used by ORS to develop Threshold Effects Exposure Limits (TELs) (MassDEP, 1990), an ambient air exposure guideline based on consideration of threshold-type health effects, developed for MassDEP's air toxics program. The ATC values are equal to five times the TEL values since they do not include a program-specific safety factor of 20% to account for multi-media exposure.

  - **Other Toxicity Values developed by MassDEP/ORS** - ORS develops chronic and subchronic RfC-equivalent and RfD-equivalent values for some compounds for which no values are available in IRIS or HEAST. These values are based on available toxicological data and standard USEPA approaches for developing

reference concentrations and reference doses for threshold effects. The list of chemicals includes a number of carcinogens for which USEPA has not derived non-cancer toxicity values. These values can be accessed through the MassDEP web site at http://www.mass.gov/dep.

- **Agency for Toxic Substances and Disease Registry (ATSDR)** - ATSDR produces Toxicological Profiles for hundreds of hazardous substances. In the toxicological profiles, ATSDR develops Minimal Risk Level (MRLs) for threshold effects of some chemicals. These values are updated when the profiles are revised, if appropriate. An MRL is defined as an estimate of the daily human exposure to a substance that is likely to be free of appreciable risk of adverse non-cancer effects over a specified duration of exposure. MRLs are derived using the modified risk assessment methodology the USEPA uses to derive reference concentrations for lifetime exposure.

- **Calculation of a dose-response value using toxicity information from the literature -** Dose-response values may be derived by a qualified risk assessor or toxicologist if none of the above sources provide a toxicity value, or if more recent, credible and relevant data becomes available. USEPA approaches to the development of RfCs are described in Interim Methods for Development of Inhalation Reference Concentrations. The review and approval by MassDEP of such proposed values would depend upon the justification and documentation provided to support it.

cancer:

- **Toxicity Values Developed by MassDEP/ORS** - The Office of Research and Standards may develop unit risks for chemicals for which no values are available in IRIS or HEAST. When available, these values can be accessed through MassDEP's website at http://www.mass.gov/dep.

- **California Environmental Protection Agency (Cal/EPA)** - Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA), Department of Pesticide Regulation (DPR) and Department of Toxic Substances Control (DTSC) develop or approve cancer potency factors for use in risk assessments and as the basis for regulatory action. A list of available cancer potency factors is revised semiannually and can be obtained from OEHHA's Hazardous Waste Toxicology Section.

4.2.3 Dose-Response Information for the AP-42 Chemicals

MassDEP has compiled a list of dose-response information for the AP-42 chemicals. These include chronic inhalation RfCs or RfC-equivalents and inhalation cancer unit risk values. These values are contained Table 7.

4.2.4. Relative Absorption Factors

The Relative Absorption Factor (RAF) is used to account for differences in the absorption of a COC under assumed exposure conditions (exposure route and matrix) relative to the absorption of the COC under the experimental conditions upon which the dose-response value is based. It is used to adjust the calculated exposure in terms of exposure route and medium of exposure relative to the exposure route and medium of exposure of the chemical under experimental conditions.

In the case of inhalation criteria and inhalation exposures, the RfCs and inhalation URs are typically derived based on inhalation toxicology studies. In such a case, the route and medium of exposure would be the same as the route and medium of the study from which the toxicity information was obtained. There are cases, however, in which the RfC and/or unit risk have been derived based on studies using an exposure route/medium other than inhalation. In these cases, an RAF should be used to account for these differences.

To estimate an RAF, two factors should be identified:

- the absorption efficiency for the chemical via the route and medium of exposure being evaluated for the proposed facility, and
- the absorption efficiency for the route and medium of exposure in the experimental study which is the basis of the dose-response value for the chemical in question.

Thus, the RAF adjusts the dose (or exposure) estimates based on these ***two*** absorption efficiencies. The RAF is calculated as follows:

$$RAF = \frac{Absorption\ Efficiency_{SITE\ route/medium\ of\ exposure}}{Absorption\ Efficiency_{STUDY\ route/medium\ of\ exposure}}$$

The basis for all toxicity values used to conduct a risk assessment should be reviewed to ensure that differences in absorption efficiency have been accounted for.

4.3 Exposure Assessment

The exposure assessment is a critical component of the risk assessment process as it describes the contact between the contamination and the people who are potentially affected by it. The exposure assessment should allow for the assessment of risks posed by the solid waste facility to receptors in the surrounding area (i.e., modeling domain, see Section 4.3.3.1.2.). Both current and identified future uses of the surrounding area should be considered. For example, if a facility is located adjacent to an undeveloped tract of land that is zoned for residential development, the future use of this area as a residential neighborhood should be considered as part of the exposure assessment.

For the purpose of evaluating facility-specific risk under the Site Assignment Regulations (310 CMR 16.00) only exposure to COC via inhalation of ambient air should be assessed quantitatively in a risk assessment. This exposure involves inhalation of emissions from the facility. As described earlier, potential exposures via groundwater are addressed by the

implementation of a series of measures to prevent contamination of groundwater and subsequent exposure to the human population.

The exposure assessment generally includes two components: the exposure profile and quantitative estimates of exposure. The exposure profile describes the exposures that may occur to human receptors in the area surrounding the facility. The quantification of exposure translates the narrative exposure profile into an exposure equation resulting in a numerical estimate of exposure. These numerical estimates are subsequently used in the calculation of health risks.

A screening exposure profile should initially be used to evaluate the impact of a proposed new facility or expansion. This profile should assume continuous exposure to landfill emissions by a receptor situated at the maximum point of impact at or beyond the property line. If health risks estimated from such a scenario exceed risk management criteria, then the applicant may, on a case-by-case basis, develop a more refined exposure profile that incorporates site-specific exposure parameters. A refined exposure profile and associated assessment should, however, be protective for all receptors who are assumed to be impacted by emissions from the proposed facility.

Potential exposures to COC from the proposed facility should be based on emissions and dispersion modeling as discussed in Section 4.3.3.1.

4.3.1 Screening Case Exposure Profile

The screening case exposure profile assumes that a receptor is situated at the maximum point of impact at or beyond the property line continuously, twenty-four hours per day, seven days per week for thirty years[12], breathing air containing the modeled exposure point concentrations. The screening exposure profile conservatively assumes that a receptor never leaves the area of maximum impact for thirty years. If non-cancer and cancer risks calculated based on this exposure profile meet risk management criteria, then the development of a more refined exposure profile, based on more realistic exposure estimates, is not necessary as further refinements will only decrease risk estimates further. However, if estimated screening risks exceed risk management criteria, then a more realistic exposure profile (e.g., reflecting time the receptor spends away from home, at school, at work, etc.) should be developed as discussed below.

4.3.2 Refined Exposure Profile

The refined exposure profile should contain a narrative description of how exposure takes place in the area surrounding the facility being evaluated. The exposure profile assists the risk assessor in identifying the appropriate frequency and duration of exposure to which human receptors are exposed via inhalation to concentrations of COC in air.

Potentially exposed human receptors in the area surrounding the facility will generally comprise a diverse group that lives (or may in the future live) in the area surrounding the facility. For the purposes of the risk characterization these residents should be further divided into subpopulations based upon gender and age if those factors are indicative of a higher exposure

[12] The thirty-year annual average exposure, which represents a chronic period of time, is adopted for the LADE assessment based on work done by USEPA that identifies this value as the 95th percentile estimate of the time that most people will spend living at one residence (EPA, 1997b)

potential. Young children, women of childbearing age and the elderly are often chosen as receptors of concern in residential locations because of these factors. At industrial locations, adults may be the most susceptible receptors. However, this may not be the case if, for example, there is a daycare center on the premises. Identification of the most sensitive subpopulations should be done on a case-by-case basis. Thus, to adequately evaluate these residents, the risk assessor may conclude that all other subpopulations in the area would be subject to lower exposures and risks than those calculated. Note, though, that while the receptors are described in terms of "subpopulations" or "subgroups", the product of the risk assessment is still an estimate of the risk that applies to the protection of an individual within that group. The quantitative risk assessment focuses on individual risk not population risk.

A detailed exposure profile may be developed for what is believed to be the most highly exposed receptor in the surrounding area accompanied by the conclusion that lesser exposed receptors will also be protected. How often the exposures occur along with the length of these exposures should be addressed. The exposure profile should address the facts, data, assumptions and inferences about how exposures take place. Professional judgment is necessary, especially for proposed new facilities for which there is no actual facility-specific information on operations. Since these factors determine the magnitude of exposure (and thus the magnitude of the risk posed by the proposed facility), it is important that there be a clear description and summary of this information. The exposure profiles allow anyone concerned about the facility to read and understand what was considered in the risk characterization.

The information that is used to develop an exposure profile for a facility should be obtained via a compilation of data on the facility's proposed operation as well as on the composition and distribution of the population in the area surrounding it. Relevant information on the proposed facility and the surrounding area would include:

- the address and location of the proposed facility
- a detailed map of the proposed facility and surrounding area
- a description of the land uses at and surrounding the proposed facility
- a listing of other major point emission sources in the area regulated by MassDEP (i.e., from SSEIS)
- identification of potentially sensitive populations in the surrounding area (e.g., daycare centers, nursing homes, etc.)

Some of this information may be available through the Massachusetts Geographic Information System (MASS-GIS), which provides color plots or digital data. For a full listing of available data, contact MassDEP GIS at (617) 574-6802 or Brian.Brodeur@state.ma.us.

4.3.3 Quantitative Estimates of Exposure

Once the screening and/or refined exposure profiles have been developed, the potential exposures experienced by the receptors of concern from the proposed facility are quantified using emission and dispersion modeling as described in Section 4.3.3.1. The outputs of the modeling include the maximum annual average and the 30-year annual average estimates of COC concentrations at the maximum point of impact in the surrounding population beyond the property line and at the property line.

If the proponent chooses to do facility-specific monitoring, the results of this investigation should be used to replace only those default AP-42 concentrations that are lower in magnitude than monitored concentrations. As discussed in Section 2 of this document, a conservative approach should be used in the risk assessment in which the highest of the monitored concentration or concentration derived from an AP-42 emission factor is used in the assessment. Concentrations of VOCs emitted from decaying waste fall along a lognormal gas production curve and vary significantly over the decaying process, influenced by the age of the waste and the particular set of environmental conditions characterizing the landfill. Since it is very difficult to determine at what point along the gas production curve a data set may have been derived, MassDEP's policy regarding this issue is to use the higher concentration as an estimate of a worst-case concentration.

The several different time estimates of modeled exposure are necessary in order to evaluate all relevant exposure scenarios. A chronic exposure for humans is typically described as a period of time greater than seven years in duration. A subchronic human exposure is described as a period of time from three months to seven years. For chemicals that are carcinogenic, a lifetime average daily exposure (LADE) should be calculated. The thirty-year annual average exposure, which represents a chronic period of time, is adopted for the LADE assessment based on work done by USEPA that identifies this value as the 95th percentile estimate of the time that most people will spend living at one residence (USEPA, 1989).

4.3.3.1 Modeling Approach Used to Calculate Exposure Point Concentrations

The USEPA Landfill Gas Emissions Model (LandGEM) can be used for estimating emissions of methane, carbon dioxide and non-methane organic compounds from municipal solid waste (MSW) landfills. The model can be run using site-specific data or, if site-specific data are unavailable, using default values. Information on the LandGEM model can be found in User's Manual - Landfill Gas Emissions Model (USEPA, 1998).

Fugitive dust emissions from landfill operations due to filling, capping, waste transportation, and wind erosion can be estimated with EPA AP-42 emission equations. Toxic compounds in ash disposed in a landfill should be determined using an approved MassDEP ash sampling and analysis program.

After air pollution emission estimates have been quantified, USEPA air quality dispersion models can be used to estimate air pollution concentrations in the vicinity of the landfill. Estimates of ambient air quality concentrations should be based on air quality models contained in Supplement C to the Guidelines on Air Quality Models (Revised), EPA Publication No. EPA-450/2-78-027R-C or other state-of the-art modeling procedures approved by MassDEP.

The Guidance Document will not address the modeling protocol for estimating levels of NAAQS air pollutants. The potential impacts of criteria pollutants will not be addressed in the facility impact assessment but are addressed elsewhere in the siting and permitting process.

4.3.3.1.1 Landfill Gas and Particulate Emissions

USEPA has concluded that many compounds found in landfill gas may endanger public health if left uncontrolled. Fugitive dust associated with landfill operations may cause or contribute to a condition of air pollution. Emission rates of landfill gas compounds and fugitive particulate matter should be estimated using models and procedures approved by MassDEP.

4.3.3.1.1.1 Municipal Solid Waste Landfills

Municipal solid waste (MSW) produces emissions by three mechanisms: volatilization, chemical reaction, and biological decomposition of solid or liquid compounds into other chemical species. Volatilization is affected by the partial pressure of the constituent, concentration of the constituent at the liquid air interface, temperature, and confining pressure. Chemical reactions are also affected by temperature as well as waste composition, moisture content, and the practice of separate disposal areas for different waste types. Factors affecting biological decomposition include nutrient and oxygen availability, refuse composition, age of landfill moisture content, temperature, acidity, and waste that is toxic to bacteria.

Area Sources (Uncontrolled Emissions)

Uncontrolled area source emission estimates can be determined for individual landfills using USEPA's Landfill Gas Emissions Model (LandGEM). This theoretical first-order kinetic model can be accessed from the EPA's Office of Air Quality and Planning, Technology Transfer Network (OAQPS-TTN) website. The model can be run using site-specific data. In the absence of site-specific emissions information, MassDEP recommends using LandGEM with the USEPA AP-42 default values. LandGEM provides emission estimates after the first year of refuse is in place and provides annual estimates out to 200 years. Refuse data in Mg/year (million grams per year) should be input into the model for each active year of operation – typically, a 4 to 7 year period of time.

If required, fugitive dust emissions from landfill operations due to filling, capping, waste transportation, and wind erosion can be estimated with USEPA AP-42 emission factors. Toxic compounds in any ash disposed of in a landfill should be determined using an approved MassDEP ash sampling and analysis program.

Area Sources (Controlled Emissions)

Emissions from landfills are typically controlled by installing a gas collection system and combusting the collected gas through the use of internal combustion engines, flares, or turbines. To estimate landfill area source emissions after closure, USEPA recommends using a 75% collection efficiency if site-specific collection efficiencies are not available. During the period of time that the landfill is still active, landfill gas capture efficiency should be assumed to be 0%. Gas collection systems do not generally operate well before closure because it is too easy for air to enter the system. If applicants have an existing air permit that specifies a gas capture rate,

MassDEP will rely on that data. Absent that type of documented data, MassDEP will rely on the above default assumptions.

Point Sources (Controlled Emissions)

Collected landfill gas emissions are typically controlled by combusting the collected gas through the use of internal combustion engines, flares, or turbines. The AP-42 emission factor tables can be used to estimate the destruction efficiencies of the control systems used to destroy NMOC compounds in collected landfill gas (typically 98% or more).

Non-Municipal Solid Waste Landfills

Non-municipal solid waste facilities generally accept a specific form of waste. Examples are ash landfills and C&D landfill sites. Typical emissions of concern are fugitive particulate matter generated during processing and transportation of such wastes, and for C&D landfills, hydrogen sulfide emissions.

Area Sources (Uncontrolled Emissions)

If required, fugitive dust emissions from landfill operations due to filling, capping, waste transportation, and wind erosion can be estimated with AP-42 emission factors, or other state-of-the-art procedures approved by MassDEP. MassDEP may request case-by-case estimates of fugitive dust emission rates and other COC based upon a review of the literature.

4.3.3.1.2 Air Quality Impact Analysis Modeling Protocol

Listed below are the recommended contents of an air quality analysis modeling protocol. Applicants should meet with MassDEP staff to discuss the proposed contents of an air quality modeling protocol before submitting the protocol to MassDEP for review and approval. All estimates of ambient air quality concentrations should be based on air quality dispersion models and other requirements specified in Supplement C to the Guidelines on Air Quality Models (Revised), USEPA Publication No. EPA-450/2-78-027R-C, or other state-of the-art modeling techniques with technical merit as approved by MassDEP.

For ash landfills, the proponent should discuss with MassDEP an assessment plan and the potential need for any interactive modeling of sources with similar emissions. The results of this discussion should be incorporated into the modeling protocol.

Source Data

Facility Description: A description of the proposed landfill or proposed landfill expansion under review should be provided, including site plans and appropriate

topographic maps. Yearly trash acceptance rates (out to the year of cell closure) and geographic areas to be filled (out to the year of cell closure) should be identified.

Operating Schedules: Daily and weekly operating schedules should be described, including truckloads of waste, fill and cover operations and any emission mitigation activities.

Landfill Emission Rates: Landfill gas emission rates in grams per year for methane, NMOC, carbon dioxide and the list of AP-42 compounds should be estimated using USEPA's LandGEM model. MassDEP will accept other emission estimation techniques if they have technical merit and reflect state-of-the-art emission estimation procedures. Refuse data Mg/year should be input into the model for each active year of operation out to closure (typically 4 to 7 years). After closure, assume that 75% of the landfill gas emissions predicted by the LandGEM model will be collected and burned, unless site-specific collection efficiencies are available. During the time a landfill is still active, landfill capture efficiency should be assumed to be 0% due to the fact that before closure it is too easy for air to enter the system and thus the system does not operate well. Landfill yearly emission rates should be calculated for a 30 period of time, including the years of active filling, usually a 4 to 7 year period of time.

Stack Emission Rates: Metric stack parameters and emission rates for all stacks, flares and vents associated with the landfill gas collection system should be provided. Stack data should include height above ground, stack diameter, stack exit velocity, stack temperature and stack emission rates in grams per second for the AP-42 list of COC. The AP-42 emission factor tables can be used to estimate the destruction efficiencies of the control systems used to destroy the COC in collected landfill gas (typically 98% or more).

Receptor Network

Grid: A Cartesian receptor grid should be designed for the modeling analysis, centered on the approximate center of the proposed landfill expansion area. The network should be of sufficient detail to ensure that maximum air quality concentrations at or beyond the property line will be determined. Receptor rows and columns should be spaced 50 meters apart. The network should be 2 kilometers on a side, unless there is a need to more accurately determine air quality impacts at more distant receptor areas of concern.

Discrete Receptors: Receptor coordinates for other sensitive receptors should also be obtained (nearby residences, schools, parks). The principal purpose of discrete receptor placement is to ensure that maximum air quality concentrations are determined at all locations where the public has access.

Elevations: Receptor elevations should be obtained from USGS 1:25,000 3 m contour electronic data and/or by inspection of applicable USGS maps.

Meteorological Data

Five years of hourly meteorological data should be employed for the modeling analysis. The data should be reasonably representative of the area where the landfill is located. USEPA recommends using a 5 year data set whenever possible in order to account for year-to-year variability in wind speed and direction patterns.

Atmospheric Dispersion Coefficients

A description of the land use within 3 kilometers of the proposed site (Auers technique) should be provided in order to determine if urban or rural dispersion coefficients should be employed. A field visit with MassDEP staff may be required to ensure appropriate land use determinations.

Air Quality Models

Estimates of ambient air quality concentrations should be based on the air quality models contained in Supplement C to the Guidelines on Air Quality Models (Revised), USEPA Publication No. EPA-450/2-78-027R-C or other state-of the-art modeling approved by MassDEP. Model options and settings should be specified and justified. MassDEP recommends using USEPA's ISC3 model for estimating long-term air quality impacts from point and area source emissions associated with landfill emissions. The ISC3 model can be accessed from the USEPA's Office of Air Quality and Planning, Technology Transfer Network website http://www.epa.gov/ttn/scram/.

4.3.3.1.3 Air Quality Impact Analyses Report

Air quality impacts of emissions from landfills and /or landfill expansions should be determined following an air quality modeling protocol approved by MassDEP. All input and output files for all modeling runs should be retained for review by MassDEP.

Averaging Times of Concern

Air quality impacts at each receptor point in the receptor network should be determined for each of the AP-42 compounds. Maximum 1 year and maximum 30-year impacts for each gas should be presented for the maximum off-site location. In addition, maximum 1-year and maximum 30-year impacts for each landfill gas should be noted for all locations where the public has access.

Contents of Air Quality Impact Analysis Report

Modeling results should be presented and discussed in an air quality impact analysis report. The report should be submitted to MassDEP for review, and should document and describe all data and procedures used in the modeling analysis (source

configuration, emission calculations, point and area source model input data, air quality model options and settings, receptor network, meteorological data, and predicted air quality concentrations). A review of this information may indicate that additional modeling analysis is required to ensure that maximum air quality impact levels and locations have been identified.

4.3.3.2 Calculation of Average Daily Exposure$_{air}$

The toxicity information generally used to evaluate the risk of harm to health associated with inhalation exposures, Reference Concentrations and Unit Risk values, are air concentrations. These values are intended to be used in combination with Average Daily Exposures (and Lifetime Average Daily Exposures for carcinogens) expressed as applied concentrations. RfCs are typically used when evaluating gaseous inhalation exposures.

Gaseous air contaminants may be inhaled by the receptor of concern located in the vicinity of the facility emissions. The Average Daily Exposure to the contaminated air (ADE_{air}) is dependent upon the frequency and duration of the assumed exposures. The result of this calculation should be an estimate of applied concentration. Note that the equation is a simple adjustment of the exposure point concentration to account for the amount of time the receptor spends in the area with contaminated air.

$$ADE_{air} = \frac{[COC]_{air} * EF * EP * C}{AP}$$

Where:

ADE_{air} = Average Daily Exposure to a contaminant in air (dimensions: mass/volume; typical units: mg/m^3)

$[COC]_{air}$ = Exposure point concentration of COC in the air at the Exposure Point during the period of exposure (dimensions: mass/volume; typical units: $\mu g/m^3$).

EF = Exposure Frequency, or the number of exposure events during the exposure period divided by the time of the exposure (dimensions: time/time; typical units: hours/day, days/week)

EP = Duration of the exposure period (dimensions: time; typical units: years)

AP = Averaging Period (dimension: time; typical units: years)

C = Appropriate units conversion factor(s) (e.g., 10^{-3} mg/μg, 1 week/7 days)

For receptors assumed to be exposed constantly during the period of exposure (such as for many residential exposures), the Average Daily Exposure would be equal to the Exposure Point Concentration. Separate ADE_{air} estimates should be based on the modeled maximum annual average (for the assessment of subchronic exposure) and the thirty-year average (for chronic exposures) exposure point concentrations, as discussed in Section 4.3.3.

4.3.3.3 Inhalation of Particulate-Associated Contamination

When evaluating particulate inhalation exposures, an Average Daily Dose rather than an Average Daily Concentration is calculated. (The equations for calculating each of these values are given below.) Airborne particulates (fugitive dust) may carry COC to receptors, resulting in particulate-related inhalation exposures. The RfC and unit risk should still be used to estimate risk in such a case by converting the RfC to an RfD and the unit risk to a slope factor.

For airborne chemicals that act at the point of contact (e.g., the lungs) when inhaled, the Average Daily Exposure of these chemicals calculated in the manner described above would be used in combination with an RfC or unit risk to estimate potential risks. Under such conditions, the $ADD_{particulate\ inhalation}$ would not be calculated.

An Average Daily Dose due to the inhalation of particulate-associated chemicals ($ADD_{particulate\ inhalation}$) may be calculated as:

$$ADD_{particulate\ inhalation} = \frac{[RP]_{air} * [COC]_{particulate} * VR * RAF * EF * EP * C}{BW * AP}$$

Where:

$ADD_{particulate\ inhalation}$ = Average Daily Dose of a contaminant through the inhalation of particulates. (dimensions: mass/mass*time; typical units: mg/kg*day)

$[RP]_{air}$ = Exposure point concentration of respirable particulates (i.e., PM10) in the air at the Exposure Point during the exposure event. (dimensions: mass/volume; typical units: $\mu g/m^3$)

$[COC]_{particulate}$ = Exposure point concentration of COC in the particulate material at the Exposure Point during the period of exposure (dimensions: mass/volume; typical units: mg/kg)

VR = Ventilation (inhalation) rate for the receptor of concern during the period of exposure. (dimensions: volume/time; typical units: m^3/hour)

RAF = Relative Absorption Factor (unitless)

EF = Exposure Frequency, or the number of exposure events during the exposure period divided by the time of the exposure (dimensions: time/time; typical units: hours/day, days/week)

EP = Duration of the exposure period (dimensions: time; typical units: years)

BW = Body weight of the receptor of concern during the averaging period (dimension: mass; typical units: kg)

AP = Averaging Period (dimension: time; typical units: years)

C = Appropriate units conversion factor(s) (e.g., 10^{-6} kg/mg, 1 week/7 days)

The equation below, for calculating the ADD_{inhp} can also be used to convert between an exposure concentration (ADE_{air}) and a dose (ADD_{inhp}).

4.3.3.4 Calculation of the Lifetime Average Daily Exposure (LADE) or the Lifetime Average Daily Dose (LADD)

In order to be consistent with the toxicity values used to estimate cancer risk, the Lifetime Average Daily Exposure (LADE) or Lifetime Average Daily Dose (LADD) should be used. These values are calculated assuming that the chronic exposure to COC is averaged over a lifetime. For the purposes of quantitative risk assessment, a chronic thirty-year exposure to landfill gas is assumed and averaged over an assumed lifetime of 70 years. Thus, in the above equations (in Sections 4.3.3.2 and 4.3.3.3**)**, the exposure period (EP) should be designated as 30 years and the averaging period (AP) as 70 years.

4.4 Risk Characterization

Risk Characterization is the final step in the risk assessment process. In this step, the results of the Hazard Identification, Dose-Response Assessment and Exposure Assessment are integrated to yield quantitative measures of cancer and non-cancer risk. The Risk Characterization can be thought of as providing a link between risk assessment and risk management because it presents the numerical estimates of risk posed by the proposed facility in a context that can be used easily by risk managers to make a siting decision.

A critical component in the presentation of risk estimates is the discussion of major assumptions, scientific judgments and uncertainties inherent in the numerical risk estimates. The importance of this component cannot be overstated. The discussion of uncertainties should place the numerical estimates of risk and hazard in the overall context of what is known about the proposed facility and surrounding area and what is uncertain. The numerical risk estimates should never be interpreted as a characterization of absolute risk but should always be interpreted in the context of the uncertainties.

Inhalation risk estimates for each chemical should be combined (summed) to yield total cancer and non-cancer risks considering all chemicals for the receptor evaluated. These total risks should then be compared with specific risk management criteria as defined in Section 4.6.

A discussion of the methods for characterizing cancer and non-cancer risks and a discussion of the interpretation of Risk Characterization results within the context of the Solid Waste Facility Siting Regulations is provided below. This section also describes how uncertainties in the risk assessment should be addressed.

4.4.1 Non-cancer Risk

The measure used to describe the potential for non-carcinogenic health effects is the Hazard Quotient (HQ). For a given chemical, the HQ is the ratio of a receptor's exposure level (or dose) for a single chemical to the *"acceptable"* (or allowable) exposure level for that chemical. For exposure to multiple chemicals, the chemical-specific Hazard Quotients may be summed to calculate a Hazard Index (HI).

$$Hazard\ Index = HQ_1 + HQ_2 + HQ_3 + \ldots + HQ_n$$

A Hazard Index of 1.0 or less indicates that adverse health effects from the exposures under assessment are unlikely. When the HI is less than or equal to 1.0, the conclusion is that the proposed facility poses an acceptable risk of harm to human health.

A HI of greater than 1.0 indicates that non-cancer health effects could occur, and cannot be ruled out. It does not mean that non-cancer effects ***will*** occur. Uncertainty inherent in most toxicity benchmark values precludes identifying a specific dose above which adverse effects are likely ***and*** below which effects are unlikely. Accordingly, the probability of an effect cannot be quantified from a HI. ***For any one chemical***, it is always true that the likelihood of an effect increases as the exposure level (and therefore the HI) increases.

The uncertainty inherent in toxicity benchmark values for different chemicals differs both qualitatively and quantitatively. Therefore, for different substances, the probability of an effect increases at different rates. For example, a HI of 20 for one substance may indicate a very high probability of an effect, but may represent only a moderate probability of an effect for another chemical.

In interpreting the HQ or HI, one should consider the appropriateness of the exposure assumptions and the basis of the toxicity information used to develop the toxicity benchmark values. As a general rule, the greater the HI is above 1.0, the greater the level of concern.

In its most general form, the Hazard Quotient associated with a chemical via inhalation is calculated as:

$$HQ = \frac{ADE_{air}}{RfC} \quad \text{or, for dose equations:} \quad HQ = \frac{ADD_{air}}{RfD}$$

Where:

HQ = The Hazard Quotient associated with exposure to the chemical via inhalation

RfC = The Reference Concentration or substitute toxicity value identified for the chemical of concern for chronic exposure (in **mg/m^3**).

RfD = The oral Reference Dose or appropriate substitute toxicity value identified for the chemical of concern. (in **mg/kg/day**).

ADE_{air} = The estimated Average Daily Exposure of the chemical via the specified exposure route. (in **mg/m^3**).

ADD_{air} = The estimated Average Daily Dose of the chemical via the specified exposure route. (in **mg/kg/day**).

As mentioned previously, total non-cancer risks should be calculated for each facility. The HI accounts for inhalation exposures that a receptor may receive from multiple chemicals emitted from the proposed facility and represents the non-carcinogenic impact of that facility to receptors.

The documentation of the Risk Characterization should clearly present all mathematical equations used to calculate total non-cancer risks for inhalation.

4.4.1.1 Screening Hazard Index

Initially, the risk assessor should calculate a *Screening Hazard Index* for a given receptor by totaling all the individual chemical-specific HQs calculated as described above. A HI calculated in this way will provide a conservative[13] estimate of the true HI because it treats as additive, different toxic effects from multiple chemicals acting on different organ systems by different mechanisms of action. In fact, in a true HI, the only endpoints that should be treated as additive are those that produce adverse effects on the same organ system by the same mechanism. Thus, the screening HI will provide a conservative estimate of the actual HI because it reflects the sum of toxicities for multiple chemicals, regardless of the chemical's health endpoint, target organ or mechanism of action.

There may be multiple adverse health effects associated with exposure to a given chemical and it is the most sensitive adverse health effect observed in the scientific data which typically drives estimation of the Reference Concentration and other toxicity benchmarks. Thus, for a given group of chemicals, Reference Concentrations may be based on different toxic effects on different organ systems by different mechanisms of action.

The screening HI should be compared with the total non-cancer risk limit, which is a HI equal to 1.0. If the screening HI is less than 1.0, then no additional effort is needed to characterize non-cancer risks. However, if the screening HI exceeds 1.0, the risk assessor may then group together chemicals with similar toxic effects and mechanisms of action and calculate a separate HI for each group.

Separate HIs should be calculated for different exposure periods, both subchronic and chronic.

4.4.1.2 Health Endpoint-Specific Hazard Index (Multiple Chemicals)

The procedure for segregating HIs by effect and mechanism of action is not simple and should be performed by a toxicologist. If the segregation is done improperly, an underestimate of the true hazard could result. Segregation of HIs requires identification of the major health endpoints of each chemical, including effects observed at higher doses than the critical effect on which the toxicity value is based. This is because the critical effect for one chemical may not be relevant for other chemicals and doses of other chemicals may not be additive for that effect. On the other hand, additive impacts could be important for other health endpoints that are only expected at higher doses.

[13] Current USEPA methodology is based on additivity of risk. It is acknowledged however that there is an inherent uncertainty in the assumption that the addition of risks is a conservative approach. Actual risks may be over-estimated if this assumption is correct or they may be underestimated since possible synergistic effects are not addressed.

Major effect categories that should be considered in segregating chemicals include neurotoxicity, developmental toxicity, reproductive toxicity and immunotoxicity. Adverse effects also should be categorized by target organ (i.e., hepatic, renal, respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal and dermal/ocular).

Once chemicals have been categorized, total inhalation hazard indices (for subchronic and chronic toxicity) for chemicals with similar health endpoints and mechanisms of toxicity should be calculated by summing the chemical-specific HQs calculated for each of these chemicals. Each HI should be compared with MassDEP risk management criteria for siting solid waste facilities as presented in Section 4.6.

4.4.2 Cancer Risk

The potential for carcinogenic (i.e., non-threshold) health effects is characterized as the Excess Lifetime Cancer Risk (ELCR). The ELCR represents the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. For a given chemical, the estimated ELCR is the product of the receptor's quantified exposure and a measure of carcinogenic potency. The typical measure of carcinogenic potency for inhalation is the USEPA Unit Risk (UR) value.

In its basic form, the ELCR associated with exposure to a given chemical via a particular exposure pathway is estimated as follows:

$$ELCR = LADE_{air} \times UR \quad \text{or, for dose equations:} \quad ELCR = LADD_{air} \times SF$$

Where:

ELCR = The Excess Lifetime Cancer Risk associated with exposure to the chemical via inhalation.
$LADE_{air}$ = The Lifetime Average Daily Exposure to the chemical in air. In $\mu g/m^3$.
$LADD_{air}$ = The Lifetime Average Daily Dose of the chemical in air. In mg/kg-d.
UR = The Unit Risk for the particular chemical of concern. In $(\mu g/m^3)^{-1}$.
SF = The Cancer Slope Factor identified for the chemical, for the inhalation exposure pathway. In $(mg/kg*d)^{-1}$.

The Lifetime Average Daily Exposure ($LADE_{air}$) (and the $LADD_{air}$) is calculated from the Exposure Point Concentration using exposure assumptions identified for the receptor being evaluated. The Exposure Assessment Section of this Guidance describes the process for calculating the receptor's $LADE_{air}$. The selection of Unit Risk values is discussed in greater detail in the Dose-Response Section.

Total inhalation cancer risks should be calculated, including all Class A and B carcinogens (i.e., chemicals classified by USEPA as being known human carcinogens and probable human carcinogens). In addition, for those Class C carcinogens (i.e., those classified by USEPA as being possible human carcinogens) for which unit risk factors exist, inhalation cancer risks should also be calculated and included in the total ELCR. For those Class C carcinogens for which the available toxicity data are insufficient to quantify cancer risks, the

potential carcinogenic effects of these substances should be discussed qualitatively in the uncertainty section of the risk assessment. As discussed previously, all carcinogens for which MassDEP has provided unit risk information in Table 7 should be evaluated at a minimum.

The total ELCR for inhalation represents the total carcinogenic impact that the proposed facility has on a particular receptor. The total ELCR accounts for exposures that a receptor may receive from multiple chemicals via inhalation.

As shown by the following equation, the Total Facility ELCR can be calculated by summing all of the chemical-specific inhalation ELCRs calculated as described above.

$$Total\ Facility\ ELCR = \sum ELCR_{chemical\text{-}specific}$$

The total ELCR should be compared with MassDEP risk management criteria for siting solid waste facilities as presented in Section 4.6.

The documentation of the Risk Characterization should clearly present all mathematical equations used to calculate Total Facility Cancer Risks.

4.4.3 Available Tools

MassDEP has developed a spreadsheet for conducting a quantitative risk assessment for municipal solid waste landfills. This spreadsheet addresses the default list of COC suggested in this document. It may be accessed at the MassDEP web site at http://www.mass.gov/dep. For certain proposed landfills or expansions that need to consider additional chemicals (e.g., such as for a facility that takes in greater than fifty percent of a particular special waste), the risks from these chemicals should be calculated separately and added to the risk determined using the spreadsheet.

4.5 Uncertainty Analysis

The Uncertainty Analysis is an important component of the Risk Characterization. A Risk Characterization is not considered complete unless an Uncertainty Analysis that identifies and discuses the uncertainties in the risk assessment is included. The Uncertainty Analysis should contain a narrative section that places the numerical risk estimates in the overall context about what is known and what is not known about the proposed facility or expansion and in the context of decisions that MassDEP will make about potential mitigation.

The dose-response and exposure assessment guidance presented in this document are intended to provide a consistent framework for evaluating potential site impacts. However, the numerical risk estimates calculated using this guidance, or for that matter any risk assessment methodology, should not be interpreted as precise estimates of the risk of harm to health. Due to fundamental limitations in the available science and practical limitations in the extent to which data can be obtained and analyzed, all facility impact assessments, whether of a quantitative or qualitative nature, require the exercise of scientific and professional judgment. These limitations introduce a variety of uncertainties into the process, some of which may lead to overestimations,

and some to underestimations, of actual risk. Because of this an Uncertainty Analysis section should be included in all risk assessments completed using this guidance.

The types and sources of uncertainty in the risk assessment that should be discussed in the Uncertainty Analysis include, but are not limited to:

- Identification of facility-related contaminants of concern;
- The use of modeling to develop emissions and Exposure Point Concentration estimates;
- Interpretation of qualitative and quantitative toxicological data used to develop cancer and non-cancer toxicity values;
- Development of Exposure Profile(s) and selection of exposure assumptions used in dose calculations.

Although the Uncertainty Analysis may be a qualitative assessment of uncertainties affecting the risk estimates, the risk assessor should attempt to describe the magnitude and direction of effect that a particular area of uncertainty is likely to have on the numerical risk estimates.

4.6 Risk Management

The risk management criteria that MassDEP uses to make a decision on site suitability for Level 2 assessments are based on two parameters, including facility-specific risks and emissions of VOCs from other point sources in the area. MassDEP has integrated these factors in a matrix considering the risk posed by the facility itself and the risk posed by nearby facilities.

The facility-specific risk is estimated using quantitative risk assessment as described in this document and is represented as estimated Total Facility Hazard Index (HI) and Excess Lifetime Cancer Risk (ELCR). Absent any other significant factors, the risk management criteria that MassDEP has established for the Massachusetts Contingency Plan (MCP) should apply to a proposed facility. These criteria include a facility HI of one (1) and an ELCR of one in one hundred thousand (1×10^{-5})[14].

Proposed facilities that pose a *de minimis* risk are generally approvable at any location. A *de minimis* risk is generally considered an insignificant risk. A *de minimis* risk is defined as a Total Facility ELCR of one in one–million (1×10^{-6}) and a Total Facility HI of 0.1. Where a facility exceeds *de minimis* risk and there are other significant emissions of VOCs in the immediate area, more stringent risk management criteria may be appropriate.

The risk posed by other facilities in the area is qualitatively evaluated using a sum of total VOC emissions from air point sources[15] within a mile of the proposed facility, unless otherwise determined by MassDEP. The quantification of cancer and non-cancer risk posed by these

[14] These are the same risk management criteria that apply to exposures associated with the post-closure, off-site migration of COC (including landfill gas emissions) from Solid Waste Management Facilities pursuant to the "*Adequately Regulated*" provisions of the MCP (310CMR 40.0114)

[15] As listed in MADEP's Stationary Source Emissions inventory System database

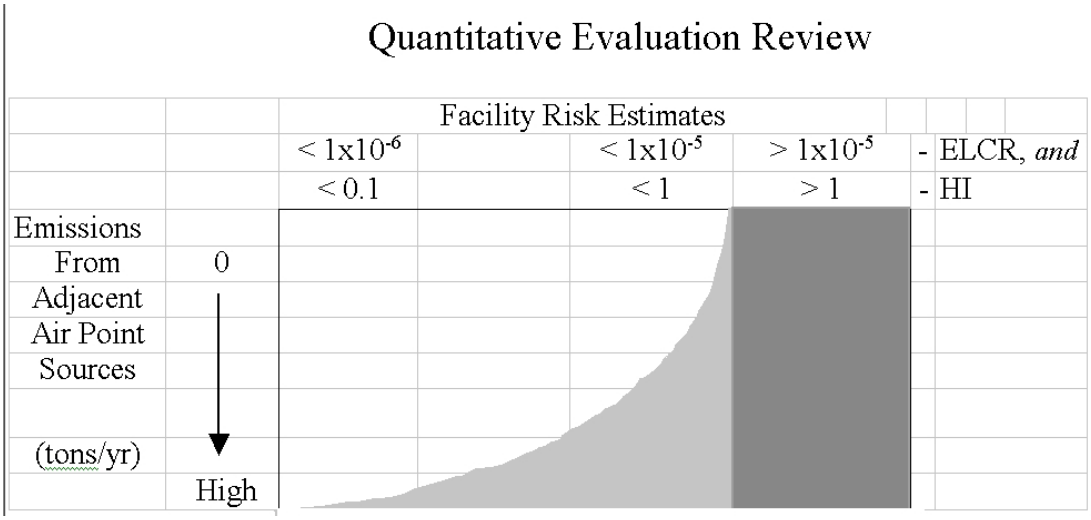
emissions is not required. As discussed in Section 1.2, use of this indicator assumes that the higher the emissions are from adjacent air point sources, the higher is the potential risk in the community affected by these facilities. Total VOC emissions should be compiled from the MassDEP SSEIS database from all point sources registered in the database that are within one mile of the proposed facility's perimeter, unless determined otherwise by MassDEP. This total should also include emissions from all existing point solid waste facilities at the proposed location. The facility proponent may choose to conduct multiple facility source modeling and quantitative risk assessment of the adjacent sources to provide a refined estimate of overall risk[16].

Facility specific and emissions of total VOCs from point sources in the area are evaluated within the context of a number of other criteria including other factors affecting environmental conditions in the community, uncertainty of the available quantitative data and the status of any commitment to clean up any surface and groundwater contamination to comply with applicable laws and regulations if the plan is a proposed landfill expansion. (A remediation plan must be approved by MassDEP before the expansion is approved.). Other factors affecting the community's environmental conditions might include possible mitigation/offset measures offered by the proponent, expected future change to emissions from facilities in the area, types of land uses, and specific particulate matter sources such as solid waste management facilities, junk yards, auto salvage shops, bus and truck depots, etc., and the environmental impacts of not constructing the facility.

Figure 2, entitled "Quantitative Assessment Review" illustrates MassDEP's risk management approach for evaluating quantitative information that has been developed using the protocol described in this document. The darkly shaded area below represents those facilities with an estimated Excess Lifetime Cancer Risk (ELCR) greater than one in one hundred thousand or an estimated Hazard Index greater than one. Outside the darkly shaded area, the facility itself poses an acceptable risk. The facility site may be approved unless emissions from adjacent air point sources are high. In that case, additional mitigation may be required.

[16] The facility proponent should consult with MADEP prior to initiating such work. Such an analysis could be part of the initial proposal, prior to a requirement for mitigation, prior to the issuance of a negative site suitability report, or as part of a request for reconsideration.

Figure 2.



In general, MassDEP would likely issue a positive site suitability report if the risk management criteria are clearly met, suggest mitigation measures if the results are near the proposed limits, or require changes to the proposal or mitigation measures if one or more of the criteria are exceeded. Mitigation options may include controls on emission sources at the site and/or off-site mitigation.

MassDEP's assessment will be based on site-specific factors. Where the combination of factors indicates that the location may not be suitable for the proposed facility, the burden of proof is on the applicant to overcome the presumption that the facility would result in unacceptable environmental and public health impacts.

SECTION 5: Water Resources

Proponents of landfill expansion projects must evaluate the impacts of the existing facility on groundwater and surface water. Where an existing facility has affected groundwater or surface water, the risk of harm to public health and the environment from the contamination must be characterized, and a plan for remediation developed if necessary for compliance with appropriate water quality standards. MassDEP will review plans for assessment and remediation in conjunction with its review of applications to construct landfill expansions, and will establish permit conditions requiring implementation of remedial action plans where necessary.

MassDEP has published a separate guidance document titled *Guidance for the Assessment of Groundwater and Surface Water for Solid Waste Facility Site Assignment and Permitting in Support of 310 CMR 16.00 & 19.000*, which provides more extensive guidance on what groundwater and surface water assessments should cover. This guidance includes a discussion of important considerations that should be addressed regarding the assessment of water resources around an existing or expanded solid waste facility. The overlap between the MCP (310 CMR 40.0000) and site assignment (310 CMR 16.00) is discussed with regard to water resources, including the MCP "adequately regulated" provision. This guidance specifies the performance standards that should be met for the assessment of water quality. In addition, it also includes checklists to assist in identifying the components of the water assessment.

SECTION 6: Facility Impact Assessment Report Content and Submission Process

This section addresses the minimum types and amounts of information that should be submitted in a timely fashion in support of a Level I or Level II assessment. The Facility impact assessment submitted in support of a decision for site suitability or authorization to construct permit should provide a comprehensive picture of the risks associated with the proposed facility in accordance with this Guidance Document.

Appendix A of this document contains a checklist, entitled "Checklist for Facility impact assessment of Solid Waste Facilities", that summarizes the minimum descriptive and technical components that the Facility impact assessment should include. This checklist may be used for planning an optional Scope of Work or in preparing the report within the applicable permit application process. A discussion of report content is provided in Section 6.1. The provision for submitting an optional Scope of Work is discussed in Section 6.2. The timing and requirements of the overall permit application process are discussed in Section 6.3.

6.1 Report Content

The facility impact assessment report should include the descriptive and technical information described below. The report should include an overview that includes a basic description of the site and of the proposed facility/expansion. Important components of the overview should include:

- the purpose of the assessment (i.e., is it for a new site assignment or a modification of an existing one);
- the proposed development schedule (if there are multiple stages);
- historical and current use of the site;
- a description of the location (including an address) of the proposed facility;
- important topographical and meteorological features of the area and/or the facility itself;
- a description of best management practices (BMPs) that will be incorporated in the design and operation of the facility;
- a map of the facility and its surroundings (indicating the permitted area of the proposed landfill or expansion), including:
    - the location of any receptors;
    - amount and types of waste to be disposed;
    - the proposed capacity of the facility; and
    - a justification for the selected method of assessment (i.e., Level I or Level II).

The report should next describe the basic components of the qualitative or quantitative assessment. For a Level I qualitative assessment, the report should provide information on facility size, best management practices (BMPs) proposed for the facility and information on emissions from adjacent sources, preferably within the context of the information presented in the overview.

For a Level II quantitative assessment, the following additional information should be submitted:

- **an overview of the general modeling approach** - The name and reference information for the emissions and dispersion models to be used should be included in this information.

- **a description of modeling inputs and assumptions -** This information should include appropriate documentation as to the source of these factors, including the source of meteorological data used for modeling;

- **basic risk assessment components** – This information should include the list of Chemicals of Concern (COC), along with the basis upon which the list was compiled, the list and sources of dose-response information, a description of risk assessment exposure assumptions and adjustments made to exposure point concentrations, a description of equations used to calculate non-cancer and cancer risks and a description of the uncertainties inherent in the modeling and risk assessment calculations;

- **a summary of tons per year VOCs emitted from adjacent facilities within a mile of the solid waste facility –** This information should include a brief description of the facilities identified and the types of VOCs they generate. The printout from SSEIS should be included in the report. For a landfill expansion, the quantification of facility-related VOC emissions should also include an estimate of total VOCs generated from the existing portion of the solid waste facility as available from SSEIS.

- **a description of current and proposed BMPs at both the existing portion of the facility, if applicable, and the new or expanded area** - This information should include a description of all BMPs currently in place at the existing facility, a description of the landfill double liner system that will be installed at the new or expanded portion of the facility, as well as a description of all BMPs to be installed.

Finally, for any landfill for which an expansion is proposed, the report must include an assessment of the impacts of the existing facility on groundwater and surface water. See Section 5 and Appendix B for guidance on conducting this assessment and determining whether remedial action is needed. Appropriate documentation as specified in this Appendix should be submitted to support the assessment of groundwater and surface water resources.

6.2 Submission of Proposed Facility impact assessment Protocol and Scoping Activities

For facilities that take in a large amount of non-traditional or special wastes or in cases in which the default modeling and/or impact assessment approaches presented in the Guidance Document are inappropriate, the facility assessment report may be preceded by an optional scope of work (SOW) or report protocol A SOW may be submitted by a facility applicant for MassDEP review and feedback. The facility applicant should submit one (1) copy of the SOW directly to the appropriate regional office, and two (2) copies of the SOW to MassDEP-Boston, at the following address:

Massachusetts Department of Environmental Protection
Bureau of Waste Prevention
Attn.: FIA Review
One Winter Street – 8th Floor
Boston, Massachusetts 02108

The applicant should contact the appropriate MassDEP regional office to discuss the applicant's project and determine whether a SOW review is necessary. MassDEP will review a draft SOW if necessary and provide either written comments and/or hold a scoping session to discuss comments with the applicant. The appropriate regional office will schedule and coordinate any necessary scoping session. In addition, the appropriate regional office will coordinate all communication to MassDEP-Boston regarding any review of a proposed SOW.

The SOW may describe the planned content of the report, or details pertaining to other aspects of the assessment including, for example, landfill gas sampling and analysis protocol, modeling methodologies, proposed changes to default methods or data sources or other alternative assessment approaches. After the protocol has been reviewed, the proponent may prepare the final facility impact assessment report, guided by the decisions made in the SOW. The SOW should be submitted well in advance of the beginning of the affected permit review period (including both the administrative and technical review periods) to allow time to coordinate the preparation of the impact assessment report with all other required permit application submittals.

6.3 Submission of a Facility impact assessment within Applicable Permit Applications

Permit applicants must comply with the permit submittal requirements governing the specific solid waste management facility permit being requested (e.g., 310 CMR 16.04(b) for a Site Suitability Report. In addition to the submittal requirements stated in 310 CMR 16.00, the applicant should submit one (1) copy of the permit transmittal form along with three (3) copies of the complete impact assessment report, including all supporting documentation, to MassDEP's Boston office at:

Massachusetts Department of Environmental Protection
Bureau of Waste Prevention
Attn.: Facility impact assessment (FIA) Review
One Winter Street – 8th Floor
Boston, Massachusetts 02108

Increasingly, the Massachusetts Environmental Protection Act (MEPA) has required either the facility impact assessment or at the very least, a discussion of the applicant's proposed plans to proceed with such an assessment as required in 310 CMR 16.00. MassDEP encourages a facility impact assessment during the MEPA process. The performance of an impact assessment during the MEPA process allows the facility applicant additional time to conduct the assessment and to receive comments from MassDEP prior to MassDEP's review of the impact assessment report during permit application review. If the applicant conducts a facility impact assessment during the MEPA process, the applicant should submit one (1) copy of the

Environmental Notification Form and any subsequent Environmental Impact Report (including any subsequent Supplemental and Final Impact Reports) to the appropriate MassDEP regional office and three (3) copies of the facility impact assessment to MassDEP's Boston office at:

Massachusetts Department of Environmental Protection
Bureau of Waste Prevention
Attn.: Facility Impact Assessment (FIA)Review
One Winter Street – 8th Floor
Boston, Massachusetts 02108

If an applicant has completed a facility impact assessment for the proposed facility for MEPA, the applicant should resubmit one (1) copy of the impact assessment to the appropriate MassDEP regional office and three (3) copies to MassDEP's Boston office (at the above address), including all relevant appendices cited in the impact assessment, all public and MEPA comments received with respect to the impact assessment, and documentation of MEPA's acceptance of the facility impact assessment (this may be in the form of MEPA's final comments and Project Certification). MassDEP will review impact assessment reports submitted as part of site assignment applications of solid waste facility permit applications. If MassDEP identifies deficiencies in the report, MassDEP will provide comments to the facility applicant.

For Site Suitability Permit Applications (310 CMR 16.00):

1. During the initial 40 days of the Review Period, MassDEP may require the applicant to respond to any comments it has received from the local board of health and other interested persons pursuant to 310 CMR 16.11 (3) (a).
2. The Applicant may modify its impact assessment within the initial 40 days of the Review Period in accordance with 310 CMR 16.11 (3) (a-b) Application Response and Modification.
3. If MassDEP determines that the deficiencies are significant in accordance with 310 CMR 16.11 (5) MassDEP may require the applicant to provide additional information. At the point of MassDEP's request for additional information the applicant may:
    a. Submit the information and be subject to 310 CMR 16.11 (3)(b)(c) modification of application regulations
    b. Formally withdraw the site suitability application until such time as a complete application, including a complete facility impact assessment, may be submitted; or
    c. Let MassDEP continue its review of the unmodified application.

MassDEP reserves the right to rescind any approval of a facility impact assessment if significant information is received in the future regarding the scientific integrity of the information in the impact assessment report. In addition, MassDEP will require all BMPs and mitigation activities proposed by the applicant to be implemented as a condition of the applicable facility permit. Failure to implement BMPs and other approved commitments would constitute a violation of the facility permit and may result in enforcement actions.

References

Massachusetts Department of Environmental Protection (MassDEP). July, 1988. Ash Sampling and Analysis Guidance. SWM-9-7/88 (as further clarified in 7/97 MassDEP communications to facility operators).

Massachusetts Department of Environmental Protection. (MassDEP). July, 1995. Guidance for Disposal Site Risk Characterization – in Support of the Massachusetts Contingency Plan. Bureau of Waste Site Cleanup and Office of Research and Standards.

United States Environmental Protection Agency (USEPA). December, 1989. Risk Assessment Guidance for Superfund (volume 1) – Human Health Assessment Manual (Part A) – Interim Final. Office of Emergency and Remedial Response.

United States Environmental Protection Agency (USEPA). 1997a. Compilation of Air Pollutant Emission Factors, AP-42. 5th ed. Supplement C. Office of Air Quality Planning and Standards. Research Triangle Park, NC.

United States Environmental Protection Agency (USEPA). 1997b. Exposure Factors Handbook. National Center for Environmental Assessment

United States Environmental Protection Agency (USEPA). 1997c. Health Effects Assessment Summary Tables (HEAST). Solid Waste and Emergency Response. FY 1997 Update.

United States Environmental Protection Agency (USEPA). 1997d. Emission Factor Documentation for AP-42 Section 2.4 – Municipal Solid Waste Landfills –Revised.

United States Environmental Protection Agency (USEPA). February, 1998. User's Manual – Landfill Gas Emissions Model. Air Pollution Prevention and Control Division; Control Technology Center; and Office of Research and Development.

United States Environmental Protection Agency (USEPA). 2001. Integrated Risk Information System (IRIS) database. http://www.epa.gov/ngispgm3/iris/subst/index.html.

APPENDIX A

Checklist for Facility impact assessment of Solid Waste Facilities

Checklist for Facility impact assessment of Solid Waste Facilities

For All Level 1 and Level 2 Assessments

Facility Based Impact Assessment (FIA) Submissions:

Scope of Work (SOW) >>(See Section 6.2)

- ❑ Submit one (1) copy of the proposed SOW to the appropriate MassDEP regional office
- ❑ Submit two (2) copies of the proposed SOW to MassDEP - Boston office

FIA Assessment Performed During MEPA >>(See Section 6.3)

- ❑ Submit one (1) copy of the ENF and subsequent EIR (including any subsequent SEIR and FEIR) to the appropriate MassDEP regional office
- ❑ Submit three (3) copies of the FIA assessment (including all relevant appendices cited in the FIA assessment) to MassDEP – Boston office
- ❑ If submitting an FIA assessment performed during MEPA within a formal Site Assignment or Solid Waste Facility Permit, submit:
    - One (1) copy of the FIA Assessment to the appropriate MassDEP regional Office
    - Three (3) copies of the FIA Assessment to MassDEP – Boston office
    - All relevant appendices cited in the FIA assessment
    - All comments received regarding the impact assessment from all interested parties and MEPA
    - Documentation of MEPA's acceptance of the FIA assessment

General FIA Assessment >>(See Section 6.3)

- ❑ Submit one (1) copy of the FIA Assessment to the appropriate MassDEP regional Office
- ❑ Submit three (3) copies of the FIA Assessment to MassDEP – Boston office

All Submissions to MassDEP – Boston should be directed to:

Massachusetts Department of Environmental Protection
Bureau of Waste Prevention
Attn.: FIA Review
One Winter Street – 8th Floor
Boston, Massachusetts 02108

Acronyms:
SOW – Scope of Work
ENF – Environmental Notification Form
EIR – Environmental Impact Report
SEIR – Supplemental Environmental Impact Report
FEIR – Final Environmental Impact Report
FIA – Facility impact assessment

<u>Descriptive Information</u>: >>(See Section 6.1)

- ❑ Description of proposed facility/expansion, potentially exposed receptors and surrounding land uses within one mile
  - ❑ Purpose of assessment
  - ❑ Information on historical/current use of site
  - ❑ Description and address of proposed facility/expansion
  - ❑ Pertinent site-related information (e.g., topography, meteorology, etc.)
  - ❑ Proposed capacity of the facility in tons per day
  - ❑ Description of development schedule
- ❑ Level of impact assessment (i.e., Level 1 or Level 2) with justification for selection
- ❑ Map of the proposed facility/expansion and surroundings
  - ❑ location of receptors indicated
  - ❑ map of permitted area of the proposed facility

Industrial Emissions from Adjacent Sources >>(See Section 1.2)

- ❑ Description and quantification of total facility-related VOC emissions within one mile of the facility provided (from SSEIS database)
  - ❑ Printout from SSEIS
  - ❑ For a facility expansion, total VOC estimate from SSEIS for the existing facility

Best Management Practices >>(See Section 2.1)

- ❑ Detailed assessment of the proposed facility with respect to the major "areas of concern"
- ❑ Proposal of specific BMPs to be implemented by the facility and a detailed discussion regarding their ability to reduce potential impacts in relation to the major "areas of concern"

<u>For All Landfills</u>

Water Resources Assessment: >>(See Section 5.0 and Appendix B)

- ❑ Description of cleanup plan to achieve groundwater and surface water standards under the Solid Waste and MCP programs (if applicable). (See Section 5 and separate MassDEP guidance titled *Guidance for the Assessment of Groundwater and Surface Water for Solid Waste Facility Site Assignment and Permitting in Support of 310 CMR 16.00 & 19.000*.)

For Level 2 Assessments – Quantitative Assessment

Hazard Identification >>(See Section 4.1)

- ❑ Chemicals of Concern (COC) identified
  - ❑ For a MSW landfill, AP-42 chemicals
  - ❑ Exceptions to AP-42 list (based on monitoring and/or literature information) explained and MassDEP approval obtained before risk assessment undertaken
  - ❑ Based on nature of waste proposed to be handled by the facility (e.g., special wastes; other) additional COC proposed and approved by MassDEP (if applicable)
- ❑ Toxicity profiles for each COC

Dose-Response Assessment >>(See Section 4.2)

- ❑ Dose-response information (including source and/or values) identified for each COC in the risk assessment
  - ❑ Use of the toxicity information for the AP-42 chemicals
  - ❑ Source of and/or dose-response values proposed and approved by MassDEP for other COC

Exposure Assessment >>(See Section 4.3)

- ❑ Screening case exposure profile and/or refined exposure profile developed
  - ❑ Name of emissions model used
  - ❑ Name of dispersion model
  - ❑ Receptor network defined and (for refined exposure profile) sensitive receptors identified /included
- ❑ Modeling inputs defined
- ❑ Modeling outputs defined
- ❑ Risk assessment exposure assumptions defined and explained (including source of data)
- ❑ Description of approach used to calculate exposure point concentrations

Risk Characterization >>(See Section 4.4)

- ❑ Description of approach used to calculate non-cancer and cancer risks
- ❑ Statement as to whether the MassDEP-developed spreadsheet was used in conducting the risk

Uncertainty Analysis >>(See Section 4.5)

- ❑ Description and quantification of facility-related VOC emissions from SSEIS database